COLONY OF SIERRA LEONE

ANNUAL REPORT

of the

Department of Agriculture

for the Year

1949

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Annual Report of the Department of Agriculture for the Year 1949

SECTION I—INTRODUCTION AND POLICY

The 1948/49 rice crop was about normal although some shortages in supplies were experienced in the larger towns shortly before the 1949/50 crop started to come on the market—with farmers receiving such good prices for export produce, more rice is being consumed in the rural areas. The 1949/50 crop was slightly above average; light late rains reduced yields in the Scarcies estuary where the crop was affected by the exceptionally early return of saline conditions, but this was offset by the absence of flood damage anywhere during the year. The production of subsidiary food crops was very satisfactory and production of export crops was the best for many years, the export figures showing an increase over 1948 of 17 per cent in tonnage and 31 per cent in value.

2. 1949 saw the publication of Mr. Childs' ' Plan of Economic Development for Sierra Leone ' which includes a five-year programme to increase agricultural production. In general the emphasis has been on increased production, with the introduction of mechanical aids to save labour and increase output; but the paramount importance of production based on correct land use is not being overlooked and, in this connexion, the work of the Agricultural Chemist and the survey being undertaken by the Soil Conservation and Land Utilisation Team—constituted in 1949—can be expected to indicate additional measures which must be adopted if agricultural production is to be maintained at a high level.

3. There has been no major change in departmental policy which is primarily concerned with fostering optimum land use. The chief work of the department has continued to be investigations and experiments to find out how farming can be made more productive and profitable, and extension activities to help the farming community to adopt improvements. The following is the approved policy and an outline of some of the more important work during the year:—

A—The Adequate Provision of Food for the People

This is to be accomplished by:—

The improvement and spread of swamp rice cultivation to such an extent that not only will the needs of the people be supplied in a bad year but there will be a surplus for export in ordinary years.

4. *Mangrove Swamp Reclamation.*—Schemes to assist individual farmers to clear mangrove lands for rice continued and progress was particularly encouraging in Bonthe District. Ninety-nine loans were issued to individual farmers, and two Native Administrations—Bumpe and Kafu Bullom—received loans for clearing blocks of mangrove swamp prior to renting to farmers. The clearing of mangrove swamps by farmers not requiring monetary assistance also continued satisfactorily.

5. *Saline Swamp Reclamation.*—In the Scarcies, where most of the tidal land which can be cultivated without empoldering or drainage has been taken up, there is an increasing interest in, and need for, schemes to bring the saline swamps into cultivation. Farmers in the Samu Chiefdom are already making good progress on their own initiative and plans are being made to assist them with loans and in other ways. In Mambolo Chiefdom a start was made with a scheme to assist the Native Administration to empolder and reclaim 300 acres of saline land. In the Colony the experimental polders at Wellington and Maswari were maintained and there was an increase in the number of plot-holders; optimum conditions of drainage and management have however not yet been attained although results are sufficiently encouraging to warrant plans for extending the present polders and starting new ones.

6. *Riverain Grasslands.*—Now that there is an Agricultural Officer permanently stationed at Bonthe it has been possible to give more attention to the development of the vast tracts of grasslands—much of which is on rich alluvial soil—in the Sewa-

Waanje flood plain. These lands are deeply flooded in the rainy season and until the introduction, by the Agricultural Department, of Indo-China rice—a deep-water ' floating ' type—cultivation was of necessity confined to small patches of short-duration and low-yielding rices. The advent of Indo-China rice made it possible to crop through the rainy season, with the result that hundreds of acres are now sown to this rice each year and expansion is still taking place. Labour is however very limited and any rapid increase in production would appear to depend on the introduction of some measure of mechanical cultivation. For lack of more suitable equipment a horticultural tractor was used at Subu in 1949 to plough and harrow a test area of four acres. A yield of 1,800 lb. padi/acre was obtained and the indication was that the use of a large tractor would be economical. Large-scale trials will therefore be started in 1950 and it is believed that these will be successful and justify plans to provide tractor services in many parts of Bonthe District.

7. *Inland Swamp Cultivation.*—The extension of inland swamp cultivation for rice continued steadily in most districts. The organised clearance of inland swamps and the renting of plots in them to local farmers has been continued through the Native Administrations and there are now thirteen of these projects totalling 375 acres under cultivation.

8. *Swamp Rice Seed Distribution.*—1,600 bushels of improved seed, suitable for growing under a wide range of conditions, were issued to farmers from Agricultural stations and Native Administration farms. The introduction, selection and multiplication of rice varieties was continued at Rokupr where there are now 157 strains under observation; new introductions were made from British Guiana, Malaya, Pakistan, Portugal and Hungary.

The Cultivation of Inland Swamps for Crops other than Rice during the Dry Season.

9. The use of inland swamps for dry season cultivation is increasing steadily. especially near the bigger towns and in thickly populated districts. The chief crops grown are sweet potatoes, early cassava, maize, tobacco and a wide variety of vegetables. Demonstration plots at departmental station and Native Administration farms and the distribution of good planting material from these centres have proved very beneficial.

The Extension of Garden and Small-field crops to serve as an Auxiliary Food Supply.

10. Each year shows continued extension and improvement in this branch of farming which is doing much to augment local food supplies. The use of village compost is increasing and the Agricultural Chemist has been carrying out experiments with fertilisers which are giving very encouraging results which are expected to have a practical application. Steps have been taken to appoint a Horticulturist, whose duties will include the development of market-gardening and fruit production.

The Improvement of Livestock.

11. The new Animal Husbandry Station at Musaia is taking shape and the major part of the building programme has been completed; delay in installing a proper water supply is however limiting the rate of progress. Two herds of Ndama cattle are now established, one being selected for milk and the other for beef production. Departmental piggeries have been maintained at Newton and Njala and these, by demonstrating correct methods of management and by providing good breeding stock for issue to local pig-keepers, have had an excellent effect in promoting this branch of animal husbandry although lack of sufficient supplies of good feeding stuffs is still a limiting factor to expansion. The addition of an imported mineral supplement has practically eliminated the previous trouble with bone weakness at the Newton piggery. The demand for breeding stock and hatching eggs of Rhode Island Red poultry continued to be heavy and considerable numbers were sold to farmers and others; there was a very serious outbreak of ' Fowl Pest ' during the year with heavy losses in most districts. Muscovy ducks have done well and are easy to manage; attempts to introduce other kinds by importing hatching eggs by air were a complete failure, and it has therefore been decided to bring out small pens of breeding birds. Small numbers of rabbits and guinea pigs were distributed for breeding purposes.

B—The Cultivation of Cash Crops and the Exploitation of Wild Trees for Export Purposes

12. Favoured by good prices there has been an appreciable and very satisfactory all-round increase in the production of agricultural produce for export, particularly palm kernels, palm oil, groundnuts and cocoa. The following table of exports shows how the post-war years, 1946–1949, compare with the war period and 1938:—

Products	1938	*Average* 1939–45	1946	1947	1948	1949
Palm Kernels:—Quantity	63,697	46,483	46,773	61,240	66,431	76,541
Value	£457,031	£381,081	£688,840	£1,301,742	£1,744,591	£2,314,038
Price	£7	£12–£4	£15	£21	£26	£30
Palm Oil:—Quantity	1,066	426	107	637	2,208	3,308
Value	£16,025	£5,270	£4,449	£30,857	£115,958	£186,348
Price	£15	£54–£11	£41	£48	£52	£56
Piassava:—Quantity	3,791	2,338	4,118	2,958	2,159	2,785
Value	£40,369	£55,655	£236,352	£150,315	£88,345	£118,744
Price	£10	£40–£10	£57	£51	£41	£43
Ginger:—Quantity	2,705	1,640	982	1,451	1,318	1,395
Value	£60,680	£53,533	£51,819	£71,258	£73,682	£146,791
Price	£22	£54–£17	£53	£49	£56	£105
Coffee:—Quantity	38	65	132	276	347	257
Value	£793	£3,319	£7,305	£15,137	£19,148	£17,165
Price	£21	£129–£17	£55	£55	£55	£67
Cocoa:—Quantity	384	477	572	439	1,379	714
Value	£5,849	£8,741	£11,653	£16,930	£102,941	£65,627
Price	£15	£22–£12	£20	£38	£75	£92
Kola:—Quantity	1,450	997	1,307	2,300	1,840	1,680
Value	£29,785	£34,922	£105,470	£229,099	£166,635	£155,216
Price	£20	£27–£41	£81	£99	£91	£92
Benniseed:—Quantity	374	197	127	3	350	287
Value	£3,700	£1,993	£1,999	£55	£11,538	£10,728
Price	£10	£11–£9	£16	£18	£33	£37
Groundnuts:—Quantity	Nil	—	—	24	890	2,454
Value	—	—	—	£506	£26,558	£71,639
Price	—	—	—	£21	£30	£29
Total tonnage all Exports	73,505	52,603	54,118	69,328	76,961	89,421
Total value all Exports	£614,232	£544,514	£1,107,887	£1,815,899	£2,351,920	£3,086,296

Note:—Quantities are quoted in tons. Prices 1939–45 are the maximum and minimum prices per ton during that period. Other year show average ruling prices per ton. These figures are all quoted from export statistics, the actual monetary value to producer would probably average two-thirds of the figures shown.

13. The total export tonnage exceeds that of 1938 by 25 per cent and 1948 by 17 per cent and the increase in value is respectively 368 and 31 per cent. Good progress has therefore been made towards reaching the target set by His Excellency the Governor when he stated, in his speech at the opening of the Legislative Council on 3rd December, 1948, that the aim was to double production in five years. The export figure for cocoa is considerably lower than in 1948 but actual production was well up on all previous years and is estimated at about 1,700 tons which will be reflected in the 1950 export figures; the position of coffee is similar. There has been a remarkable increase in groundnut production which has led to a welcome addition to the income of farmers outside the palm belt; this crop can however be very conducive to soil erosion in this country and it may be necessary to discourage large-scale planting unless suitable measures for soil conservation are practised.

14. Under the Oil-palm Planting Programme, which was begun in 1948 with the planting of some 9,000 seedlings of improved varieties of palms, 23,000 seedlings were planted in 1949. The majority of these were planted by farmers who were supplied with free seedlings from departmental and Native Administration nurseries and received help from departmental extension staff in selecting sites and planting. The number and size of nurseries are being increased and it is hoped to step up the rate of new plantings very considerably in 1950 and succeeding years. The officer-in-charge of the Oil-palm Research Station at Benin, Nigeria, has been asked to visit here in 1950 to advise on the best methods of breeding improved seed for future use as well as general measures for promoting the development of the oil palm industry in Sierra Leone.

15. During the year a big effort was made to encourage farmers to make new plantings of cocoa and to take better care of existing plantations. There was a very encouraging response and it is estimated that new plantings totalled not less than 1,000 acres. In Pujehun District a loan system was started to assist farmers to establish new plantations and 33 farmers took advantage of this facility. Organised drives against monkeys were continued in the South-western Province; this was the second year of this scheme and brought the number of monkeys destroyed to over 60,000, resulting in an appreciable increase in cocoa production and a similar reduction in damage to food crops.

C—Soil Conservation

16. The most important objective of the department is the introduction or maintenance of agricultural practices based on correct land use and soil conservation. 1949 saw the constitution of the long-mooted Soil Conservation and Land Utilisation Team of which one member, Mr. E. S. Capstick, is an Agricultural Officer. The team was engaged in survey work for the greater part of the year and their report and recommendations will be submitted in 1950. The Agricultural Chemist has continued a series of investigations and experiments the results of which should provide a better understanding of many of the basic problems underlying existing or proposed systems of land use.

D—The Improvement in the Preparation Quality and Marketing of Produce

17. The Department of Commerce and Industry which had, in the previous year, taken over the functions of the Marketing Branch of the Department of Agriculture, took over the Produce Inspection Branch at the end of 1949; in future, the responsibilities of the Department of Agriculture will be largely confined to production and the improvement of produce while it is still in the hands of the farmer. A report—paragraphs 79–83—on the activities of the Produce Inspection Branch, is therefore included here for the last time.

18. Certain processing machinery ordered by the Department of Agriculture under the ten-year development plan arrived during 1949. These included a large rice mill for Mambolo in the Scarcies and two Pioneer Oil Mills, one of which was erected at Masanki; these mills have now passed to the control of the Department of

Commerce and Industry. A modified 'planters ' rice mill was used very successfully for hulling coffee cherries and the intention is to make the services of this mill available to local farmers in 1950; this should not only improve quality but effect some increase in production as labour is not always available to process the whole of the crop by hand methods. Intensive propaganda and instruction in correct methods of fermenting and preparing cocoa for the market resulted in a notable improvement in quality although it was unfortunate that few producers received a corresponding direct monetary reward.

E—Agricultural Education

19. The training of students to fill the posts of Agricultural Instructors in the department was continued at Njala Training College. Native Administration demonstrators continued to be trained at the various Agricultural Stations and have proved very valuable for straightforward extension work in restricted subjects and areas. Two Laboratory Assistants, Messrs. C. T. Pyne and J. O. Belford, proceeded to the United Kingdom to read for Science degrees and two students from the Njala Training College continued in Science courses at the Prince of Wales School, Freetown in preparation for taking Degree courses in Agriculture. Extension staff continued to co-operate with the Department of Education by rendering practical assistance to schools maintaining school gardens or farms.

F—Research

20. Shortage of Public Works Department staff held up construction work for the new Rice Research Station at Rokupr and it now appears unlikely that the building programme will be completed until the latter part of 1951. The reports of the Officers-in-charge of the Research Sections of the department are given *in extenso* in the latter part of this report.

SECTION II—THE WORK OF THE DEPARTMENT OF AGRICULTURE

A—Organisation and Staff

21. Departmental Headquarters were maintained at Njala which is also the location of the central general experimental farm, the research laboratories and the Training College. The geographical division of the territory into Agricultural Circles for administrative purposes, as well as the location of these and their main crops and activities, were given in detail in the 1948 report. All agricultural stations have been maintained and the establishment of a Horticultural Station near Freetown is being planned. Increasing use is being made of Native Administration farms and nurseries, which now number about forty, to provide seed and planting material of economic crops for issue to local farmers.

22. There was a decided improvement in the staff position by the end of the year when vacancies in the approved establishment of Agricultural Officers had been filled by the appointment of Messrs. A. P. McWilliam (on transfer from Trinidad), H. J. Williams and J. D. A. Harris. Unfortunately this improvement is not likely to last long as several losses, from retirement and transfer, can be expected soon. Attempts to fill vacancies for Agricultural Superintendents met with no success nor was it possible to recruit a second Chemist, Systematic Botanist or Horticulturist.

23. The post of Deputy Director, filled by Mr. G. W. Lines, was created to replace that of Principal Agricultural Officer and the Headquarter establishment was further strengthened by the provision of the post of Secretary, which is filled by Mr. S. A. D. Peters. In the absence of the Director on leave, Messrs. G. W. Lines and A. F. MacKenzie acted as Director and Deputy Director, respectively. Mr. H. Macluskie was promoted to the rank of Principal Agricultural Officer, a new post created for the officer-in-charge of the Scarcies Circle which includes responsi-

bility for the general administration of the Rice Research Station at Rokupr. The retirement, at the age of 55, of Mr. S. A. Roach, who had been in charge of the Newton Farm and the Colony Circle since 1945, was a big loss to the department.

B—Agricultural Circles

South-western Circle

Experimental Station, Njala

24. *Upland Grasses.*—The study of exotic and local grasses for pasture and fodder purposes and as a fallow crop continued. Certain exotic strains of *Panicum maximum* (Guinea grass) have shown promise; two dwarf strains are likely to be of special value for pastures, as they form an excellent sward; as yet, they have not shown any tendency to form defined stools, leaving bare ground between the stools; these are strains C.P.I. 8339 and C.P.I. 8387 imported from Queensland. Their growth habit is lax and leafy with very little cane. Two strains of *Pennisetum polystachyon*, one from the Gambia and the other of local origin, have shown promise as fodder crops, being more leafy and apparently less fibrous than Guinea grass. These introduced types compare favourably in both character and yield with the local strain of Guinea grass.

25. Observations on the application of superphosphate and sulphate of ammonia indicated that increased yields and leafier growth can be expected; indications so far show greater response to early application in May before the heavy rains than later application after the heavy rains in September.

26. Established plots of Guinea grass used for grazing trials and yield of cut fodder, both began to show a decline in production; dressings of fertilisers were applied, and the plots rested; a definite recovery in growth had been noted by the end of the year.

27. *Wetland Grasses.*—The plots of Guinea grass and Elephant grass on land liable to flooding were heavily invaded by lalang grass (*Imperata cylindrica*); early cuts were obtained, the manured plots still maintaining a slightly higher yield; the trial was stopped so that the lalang could be eradicated by intensive cultivation. The area of natural sward of *Panicum laxum* in a swamp liable to deep flooding gave 298 cow-days per acre grazing during the dry season, and a plot of *Axonopus compressus* (broad-leaved strain) again gave good grazing from a dense sward, which further appeared to control lalang efficiently.

28. *Leguminous Fodder Crops.—Pueraria phaseoloides* continued to give good yields and is most useful as a high protein crop.

29. *Dry Season Fodder.*—Pit silage of grass or grass and Pueraria mixtures proved relatively easy to make and palatable to stock; grass and pueraria hay was also made.

30. *Annual Crops.*—The majority of the annual crops were grown for fertiliser and manurial trials by the Agricultural Chemist and details are given in his report. A very detailed yield trial was done with Jute (*C. capsularis* and *olitorius*) and jute substitutes (*Urena lobata, Hibiscus sabdariffa, Sida acuta, Hibiscus sterculifolius*) under various conditions of soil. The results were most disappointing; jute showed marked photo periodism, flowering when under five feet in height after a very short growing period. Fibre yields were of poor quantity and quality. None of the substitutes showed any marked superiority in fibre quality or yield.

31. *Permanent Crops.*—Citrus, coffee and oil palms are the crops of most importance. Individual tree records continue for eventual selection of high yielding parent trees. Owing to a persistent, although minor, outbreak of scab on the established Marsh grapefruit, it was necessary to destroy the trees to prevent any

major outbreak or possible infection of nursery stock. Selections from high yielding trees were established before destruction. The plots of Nigerian, Angola and Deli oil-palms are the major source of seed of good types of oil-palm available for the oil-palm planting scheme. 112 bushels of seeds were produced for this purpose. 2,230 seedlings were distributed to farmers and 5,223 planted in nursery beds. In addition to these, large quantities of nursery stock of citrus, coconuts, other economic trees and ornamental plants, were distributed during the year.

32. *Livestock: Cattle.*—The Ndama herd did better than in the previous year and on the whole, the herd maintained very good health. Two young bullocks were broken into yokes for ploughing and general transport work.

33. *Pigs.*—Although there is considerable difficulty in obtaining foodstuffs the herd has maintained better health than in previous years. 32 pigs were sold locally for breeding purposes.

34. *Poultry.*—The Rhode Island Red flock was maintained. The heavy mortality in young chicks is still a major trouble in poultry rearing; 1,398 eggs were incubated and 671 sold for hatching, whilst 59 adult birds were sold for breeding. The flock of Muscovy ducks kept on free range has done very well; the flock increased to 108 birds and 38 were sold.

Extension Work

35. *Inland swamp development.*—Propaganda continued in the Bo–Pujehun area to encourage the wet and dry season cultivation of swamps. The yearly survey was not completed in Bo District owing to staff changes and the necessity to conserve travelling for more urgent work. Pujehun District showed a considerable increase in number of farmers and area cultivated, which is most encouraging; the increases over 1948 were 702 farmers and 1,160 acres. Crops in general were good; the considerable increase in Pujehun was materially helped by the favourable season which enabled farmers to complete their upland farms earlier than usual thus giving them ample opportunity to clear and plant swamps in good time.

36. *Mangrove Clearing Scheme.*—Thirty-one new farmers were issued loans, totalling £150, during the year, mainly in Bumpe Chiefdom. In addition, a loan of £100 was made to the Bumpe Native Administration to enable it to clear an area of mangrove by contract. After clearing, this area will be divided into plots and rented to farmers; by the end of the year 20 acres had been cleared. In all, 471 farmers have been granted loans to the end of 1949, and 1,108 acres have been cleared of which 545 acres were farmed. Other clearances by farmers not assisted by loans total 3,212 acres of which 2,693 were farmed in 1949.

37. *Cocoa.*—Intensive propaganda continued in Bo and Pujehun Districts. A trial loan scheme to assist farmers to make new plantations proved very popular; in addition, there was a considerable area planted without such assistance. A further drive to destroy monkeys proved most successful; a bounty of 6d. a head was given and 17,836 monkeys were destroyed. The effect of these drives is reflected in the increase in amount of cocoa marketed. Methods of fermentation still leave much to be desired, particularly as only small quantities are fermented at one time. Propaganda and demonstration by itinerant staff have however improved the quality of the cocoa very considerably.

38. *Oil-palm.*—Fourteen small nurseries were established by the end of the year mainly at various chiefdom towns. Block planting along the roadsides in Kori Chiefdom continued, 4,000 palms being planted out; losses have been very low and plants have established well. In addition ten bushels of seed were distributed for sowing direct in rice farms in Kamagai Chiefdom.

39. *Piassava.*—Fluctuating prices for Sulima grade piassava and undesirable trade practices have prevented any real sustained improvement in the quality despite intensive propaganda, but several producers have attempted to produce Prime

Sherbro grade, and in one chiefdom by communal effort under the guidance of Departmental staff, some eleven tons were marketed. It is hoped that this example will be followed by others in the future.

40. *Coffee.*—The improved prices have sustained interest in this crop and the quality of the prepared crop has been reasonably good. Some new planting was done during the year. The increased demand for Liberica coffee has been welcomed in the Pujehun District, where most plantations are of this type.

41. *Ginger.*—The price for this crop fluctuated considerably during the season, and towards the end there was a sharp drop. Quality was satisfactory, but the drop in price caused some farmers to lose interest. This is reflected in the census figures:—

Farmers		*Total Acreage*	
1948	1949	1948	1949
704	630	1,645	1,508

42. *Soil Conservation.*—The scheme for early burning of the grass fields in Moyamba District was carried through successfully with the full co-operation of all departments concerned and the people of the several chiefdoms in the Soil Conservation areas. Progress in other directions is slow, but steady expansion in mangrove clearance and inland swamp farming is encouraging

43. *Native Administration Farms and Staff.*—Only two Native Administration farms are maintained; these have been satisfactory. Native Administration demonstrators gave valuable assistance to cocoa farmers in connexion with plantation management and the preparation of the crop for market.

Scarcies Circle

Experimental Station—Rokupr.

44. *Rice Selections.*—Work on the selection and multiplication of swamp rices suitable for conditions in Sierra Leone continues; one hundred and fifty-seven strains were maintained during the year of which forty-one were recent importations under observation and 33 were pure line selections of local rices awaiting trial. Reselection of proved strains of rice was carried through to maintain genetic purity for multiplication purposes. The collection and classification of local rices continue; much work is required to clear up the difficulties of synonymity. Mass selection of white-grained strains of upland rices were made to provide material for future study. Selected promising strains were subject to observation under field conditions, before final multiplication and distribution to the extension service. Reselections of Kavunginpoothala, Ngasein, Indo-China and India-pa-lil, all show promising results. 523 bushels of pure seed strains found suitable for use in various parts of the country were raised, consisting mainly of the strains Sughandi, Lead, No. 79, D.99 and Kurulutuduwi of imported origin and Bolo 108 and Toma 112, selections from local rices.

45. *Soil fertility.*—The continuation of tidal flood conditions on the farm has greatly ameliorated the poor conditions resulting from the empoldering of recent years. Yields on the whole were satisfactory. The residual effects of empoldering, mainly the lack of uniformity in soil conditions, still prevent the use of a large part of the farms for statistically controlled experiments. Small-scale observations on partial water control continue. Trials with fertilisers were carried out on behalf of the Agricultural Chemist.

46. *Other Work.*—Trials with jute and jute substitutes, e.g. Urena lobata, were carried out; these crops were not successful. Oil-palm seedlings, yams, and other economic crops were raised for distribution in the Circle.

47. *Livestock.*—The Ndama herd, which now numbers 26 cattle, continued to do well and provides good supplies of farm-yard manure for use on the nurseries.

Extension Work

48. *Swamp Clearance Schemes.*—Mangrove swamps cleared under these schemes showed an increase in area planted to 60 acres; yields were satisfactory. In saline swamps—at present unsuitable for rice—near the estuary of the Scarcies a small demonstration area of ten acres was empoldered, and box sluices installed to control flooding; results will not be available for some little time. A small inland-swamp clearance scheme was started in Tonko, Limba Chiefdom,with good results.

49. *Oil-Palms.*—A total of 7,471 seedlings of improved types was distributed during the year. Nurseries are established at Rokupr and Port Loko, and Native Administration nurseries at eleven other centres. At some Native Administration farms small plantations of improved palms were planted as future source of seed for the chiefdoms.

50 *Irrigation and Drainage Schemes—Rosino* —The existing drains were enlarged and further drains put in the lower parts of the swamp near the main bund In addition, the upper part of the swamp was made non-tidal by separating it from the lower part with a check bund; automatic sluices provided for drainage of the upper part, at the same time increasing the efficiency of tidal flooding in the lower part There was a definite improvement in conditions but yields are still unsatisfactory; parts of the area failed to produce any crop

51. *Luti.*—Some drains were enlarged to give a better flow of water over the area, tidal flooding being allowed. Yields from the small area planted showed considerable improvement.

52. *Mechanical Cultivation.*—All work on the rice lands was carried out with a T.D. 6 track-layer tractor; a three-furrow disc plough was used in place of the mould board type, and it was found possible to plough in the surface vegetation. In the Rosino polder 52 acres were ploughed and cultivated at a cost of £1 8s. 3d. per acre. On Rokupr farm a Macormick-Deering seed drill was tried; it was set to drill at 60 lb. per acre but only delivered at the rate of 30 lb per acre, the crop was rather thin but grew well. The reaper binder was tested again, but the ground proved too soft for it.

53. The Pigmy power thresher proved satisfactory; on newly harvested rice the output was 22 bushels of rice per hour but with old stacks, when the rice heads and straw were tangled, the output dropped to ten bushels per hour.

54. *Seed Multiplication and Distribution.*—Rokupr continued to supply the bulk of the departmental requirements for pure seed of swamp rices; total seed distributed:—

Revolving Seed Scheme	500	bushels
Native Administration and departmental stations	133	„
Total	633	„

In addition, Native Administration seed farms sold or distributed on loan a total of 223 bushels of seed rice within their chiefdoms.

South-eastern Circle

55. *Experimental Farm, Kenema.*—The study of measures to maintain fertility in an upland swamp continued. To-date it is apparent that, unless manuring is done, the level of fertility in this swamp declines when under continuous cultivation. Heavy dressings of compost have been most beneficial; green manuring has failed to maintain fertility at a satisfactory level although it gives higher yields than unmanured land. The farm raised considerable quantities of various planting material required in the Circle, including swamp rice seed, mosaic-resistant cassava and improved types of oil-palm. A small herd of Ndama cattle was maintained satisfactorily through the year.

56. *Sub-station, Waima.*—This was started in 1948 and is serving a very useful purpose; considerable quantities of planting material were raised for distribution in Kono District.

Extension Work

57. *Swamp Development Schemes.*—These schemes are financed by Native Administrations; three chiefdoms, with a total of 74 acres cleared and planted, have been successful in developing inland swamps. Three other chiefdoms made provision, but for various reasons were unable to proceed with the schemes during 1949. One chiefdom was given a loan of seed rice for this purpose with some success.

58. *Native Administration Farms and Staff.*—Twenty-three Native Administrations voted a total of £2,091 for agricultural development work. Twenty-one ran small farms for the multiplication of planting material for distribution to farmers and chiefdom agricultural demonstrators were trained for specific duties either with cocoa or swamp rice.

59. *Cocoa.*—An intensive campaign to increase production in the cocoa area continued; some 700 acres of new plantations were planted during the year. Intensive propaganda on correct methods of fermenting and drying of cocoa met with ready response. A pilot scheme for central fermentaries was started at Gegbwema; this proved successful and farmers were paid a good price for wet beans; the prepared cocoa obtained the highest grade price, being very little short of Grade I. It is proposed to extend this scheme next year. A cocoa show was held at Kenema in November, which proved most successful there being 839 competitive exhibits of cocoa beans, also various exhibits of prepared cocoa and cocoa products, and demonstrations of methods of fermenting and processing.

60. *Coffee.*—The planting of this crop is still extending, but work has mainly been towards improvement of existing plantations and preparation of the crop. Owners of big plantations find it difficult to obtain sufficient labour to hull all the crop by hand. Experiments in hulling the dried cherries were carrid out with a modified ' Planters' rice mill with most encouraging results.

61. *Oil-Palms.*—A survey of wild oil palm stands in Leppiama, Kandu and Simbaru chiefdoms was done as it is proposed to establish a Pioneer Oil Mill to serve these three chiefdoms. The survey not only gives information regarding density of stands and possible source of fruit for the mill but also indicates where feeder roads will be necessary. Planting of improved types was done on a small scale.

Makeni Circle

62. *Experimental Farm, Makeni.*—The multiplication of suitable rices for inland swamps continued, yields averaged 1,506 lb./acre; this was satisfactory considering that the swamp has been in continuous cultivation since 1941. The best varieties were Sughandi, D.C. 39 and Guiana No. 79. In the swamp, dry season crops of sweet potatoes and ' Musaia ' cow pea did well. The most popular variety of sweet potato is Mississippi, and a considerable quantity of planting material has been distributed, especially to the Native Administration farms.

63. On the uplands a variety of crops was grown, the local strain of pigeon pea has proved much superior to exotic strains, all of which failed to set a crop of seed. 'Musaia' cow pea is proving superior to many other pulse crops commonly grown. Bananas continue to do well on the margin of the swamp. Pineapples are satisfactory, and planting material of the Smooth Cayenne variety is in great demand for distribution.

64. Trials with introduced types of tobacco gave encouraging results; single transplanting was superior to double transplanting in leaf yield (at a much lower cost) although leaf size was somewhat smaller but still satisfactory. Bourbon, Jamaica Hybrid and Magnum Prior were the types tried, and a fair cheroot could be made from the leaf produced.

65. *Extension Work.*—The inland swamp development schemes have progressed satisfactorily, the total area cleared is now 214 acres of which 190 acres were cultivated for rice during the wet season. At Makali damage to crops by ' bush cows ' was serious and hampered the scheme; fencing with barbed wire may mitigate this nuisance.

Dry season cultivation has not expanded very rapidily, but one plot holder, who grew beans on his plots during the dry season, had an apparent increase in yield in the succeeding crop of rice; this has aroused the interest of other plot holders.

66. The demonstration holding at Kamakwie had a successful year, and the plot holder is well satisfied with the results; a trial with fertilisers on the swamp gave a yield of rice of nearly 2,000 lb. of paddy per acre.

67. *Ploughing.*—In the Circle, fifteen new ox ploughs were sold during the year and a large supply of spares. Interest is increasing and the Mandingo farmers of the Mabole valley continue to do well. Ploughing has also proved successful on the Native Administration seed farms, six of which used ploughs during the year.

68. *Oil-Palm Development.*—During the year, 4,455 seedling palms of improved varieties were issued to farmers. Unfortunately late preparation of sites for planting hampered the work, but fairly satisfactory results were obtained. The nurseries at sub-stations and Native Administration seed farms have been enlarged to increase the supply of seedlings within the Circle.

69. *Sub-stations and Native Administration Seed Farms.*—The Makali sub-station continued to produce seed and planting material for distribution. Batkanu sub-station was reduced to the production of oil-palm seedlings. At Mabonto the oil-palm nursery was increased in size as more seed became available. The general standard of work on the Native Administration seed farms has been satisfactory; all are raising oil-palm seedlings. The swamp farms have given variable yields, but on the whole good returns were obtained. In some cases, the seed farm has also proved a successful demonstration of swamp development, and considerable interest is being shown by neighbouring farmers. The ten Native Administration seed farms produced 578 bushels of seed of good varieties of rice; the bulk of this seed is for distribution to local farmers who wish to undertake swamp rice farming.

Musaia Circle

70. *Animal Husbandry Station.*—Considerable progress was made with the station layout and building programme; most of the essential buildings were completed during the year. Unfortunately there has been an unavoidable delay in installing the water supply which has restricted the number of stock that can be kept on the station. A further area of land was surveyed for addition to the existing leased land.

71. *Cattle.*—Further Ndama stock was purchased locally during the year and two herds were established. One herd, which has a breeding nucleus of one bull and 26 cows was primarily selected as probably suitable for breeding beef type animals. They have done well during the year and show thriftiness and good weight for age figures. The second herd is of dairy type; this had as its foundation the old Teko herd, and now totals 53 animals. The record of the milk herd since it was first started in 1944 is :—

Year	*Total Milk Production*	*Average per Cow per Lactation*	*Total No. of Cows Milked*	*Average No. of Cows Milked*	*Average length of Lactation*	*Average birth weight of Calves*
1944 ..	10,136 lb.	390 lb.	26	8	152 days	30.3 lb.
1945 ..	12,356 „	722 „	16	9	203 „	34.1 „
1946 ..	13,955 „	1,077 „	18	8	337 „	35.0 „
1947 ..	15,925 „	1,108 „	18	9	294 „	35.4 „
1948 ..	16,917 „	1,225 „	21	10	285 „	38.1 „
1949 ..	19,203 „	1,381 „	19	10	263 „	39.1 „

During the last four years there has been a steady improvement in average yield of milk per lactation and at the same time the average length of lactation has been reduced.

72. The production of dairy produce showed an increase on previous years. 7 lb. butter, 27 pints cream and 36 lb. of cheese were sold from the farm.

73. *Cropping.*—The area of land now cleared of bush amounts to 119 acres; a further 60 acres of bush was thinned to establish a natural grass cover for grazing and 52 acres of natural grassland have been fenced into paddocks. Pure stands of Elephant grass (10 acres), Guinea grass (6 acres) and Andropogon gabonensis (1 acre) were planted, as well as small plots of various exotic and locally-selected strains of grasses planted for trial. Twenty-two acres of food crops were also grown; this included cassava, pigeon pea, Kono groundnuts, maize and sweet potatoes.

EXTENSION WORK

74. A small sub-station was maintained at Kabala; a considerable quantity of planting material was distributed: mango, orange, oil-palms and kola being in greatest demand. A small acreage of swamp was cultivated and produced 59 bushels of pure seed rice which were sold to local farmers. Some preliminary enquiries were made into measures to encourage the Fula cattle-owners to become settled mixed farmers.

Bonthe Circle

75. *Extension Work Mangrove Clearing Loan Scheme.*—In 1949, £261 were issued to 43 new farmers and 25 farmers who had previous loans. New fellings during the year are estimated at 489 acres, making a total of 2,839 acres felled under the scheme, of which 1,622 were planted during the year. Total loans issued now amount to £2,821 to 668 farmers, of which 450 have planted crops. In addition, 169 farmers have felled 799 acres without assistance by Government, 588 acres being planted during the year. There is an increasing interest in this work, and steady progress is being made. Unfortunately there seems to be no practical method of clearing mangrove except by hand; this, owing to lack of skilled fellers, precludes any very rapid increase in development. 70 bushels of seed rice were issued to farmers.

76. *Riverain Grasslands.*—The possibilities of dry season mechanical cultivation of the low-lying grasslands of the Sewa-Waanje flood plain were tested on a very small scale for the first time. The only tractor available was a small British Anzani horticultural tractor. A test plot of 4 acres was ploughed and harrowed. The small tractor had a certain amount of difficulty with the heavy grass and weed growth (mainly *Oryza Barthii*). After cultivation the area was sown with deep-water rice by a local farmer, who reported that less seed was required than under native methods; the plot was freer of weeds, and he obtained a 50 per cent increase in yield over his normal yield. His actual yield was approximately 1,800 lb. per acre. It is proposed to obtain a full size tractor for large-scale trials in 1950.

77. *Oil-Palms.*—A small beginning was made in planting improved oil-palm seedlings; in four chiefdoms 732 seedlings were planted out, and six nurseries established in the Circle for raising seedlings for future planting. Palm nut cracking machines are in good demand, but deliveries have been most disappointing, only three hand machines were available, no power-driven machines were received. An enterprising person made a machine from scrap metal and wood, the gearing being wood; it worked reasonably well.

78. *Piassava.*—The production of high grade Prime Sherbro piassava is still very limited; continuous propaganda has done much to maintain the standard. A beginning was made with a scheme to assist the people to clear creeks of sudd to facilitate canoe transport and improve access to large areas of raphia swamp suitable for exploitation. The long creek from Lake Kwako to the Waanje River was finally cleared and greatly improved communication with one of the main piassava-producing areas.

79. *Piassava Marketing Societies.*—The two started by the Registrar of Co-operative Societies in 1948 received advice and help on the production side and they made their first sales of Prime Sherbro during the year.

80. *Copra.*—Five drying kilns were completed, but little copra was produced owing to uncertainty regarding the price, and the attraction of high prices for whole green nuts for export.

81. *Produce Inspection.*—The supervision of the work of the Produce Inspection staff in the Circle made a heavy demand on the time of the Agricultural Officer in charge of this Circle.

Colony Circle

Experimental Station, Newton

82. The work of the station continued along previous lines: the intensive cultivation of small valleys; the development of anti-erosion measures on the poor sandy soil, with the establishment of suitable tree crops and grass leys, combined with stock farming.

83. *Crops. Valley Cultivation.*—Intensive cultivation throughout the year, with rice during the rainy season and market garden crops under irrigation, continued successfully. Despite the poor soils, and difficulties which arise with raw sub-soil when plots are first levelled off in the valleys, reasonable crops of rice were obtained. With the use of fertilisers and compost, good crops of many varieties of vegetables were obtained, with simple irrigation. The fruit trees on the upper terraces suffered from drought during the dry season; some means of applying water to these higher terraces would possibly increase production considerably, particularly bananas. Intensive cultivation cannot avoid the occurrence of wilt in tomato; partial control was achieved by using formaldehyde for soil sterilisation before planting.

84. *Upland.*—Citrus, oil-palms and mangoes have established and grown well; the use of D.D.T. worked into the soil gave protection to oil-palms from the dry-season attacks of termites. Cashews and Avocado pears suffered from drought in the dry season. The grass paddocks of Guinea grass (*Andropogon gabonensis*), and *Setaria kasungula* have established well; artificial fertilisers and compost help materially in establishing these on the poor soils. Combined with contour ridging, erosion is reduced considerably. Attempts to control lalang (*Imperata cylindrica*) by heavy grass cover show promise. Andropogon and Molasses grass seem to be particularly suitable for this purpose but *pueraria phaseoloides*, which is also being tried, was very slow in starting and so far has done little to suppress the lalang.

85. *Livestock. Pigs.*—These have done very well; the addition of an imported mineral supplement, and using a paddock for daily exercise, has practically eradicated the previous trouble with posterior paralysis and bone weakness. Live weight gains were satisfactory though not as good as hoped owing to difficulties in obtaining sufficient good foodstuffs. The cost of producing a 150 lb. pig is roughly 6d. a lb. live weight. 23 pigs were sold for breeding purposes and 90 for slaughter. The piggery showed a profit on its working during the year.

86. *Cattle.*—The small herd of Ndama thrived and the working beasts were most useful for carting and ploughing. The main object of the herd is to provide the necessary organic manure for the farm.

87. *Poultry.*—Breeding and distribution of Rhode Island Red fowls continued, but received a severe setback owing to an outbreak of fowl pest, which destroyed the bulk of the stock. Muscovy ducks do very well and a large flock was built up; they require little attention and flourish on free range.

88. *Small Livestock.*—Rabbits and guinea pigs continue to do well. They are in great demand locally.

89. *Reclamation of Saline Swamps: Maswari.*—In the original polder good crops of rice were obtained, a yield of 1,745 lb. per acre of padi being obtained; a fertiliser experiment gave a yield of 2,194 lb./acre. Six acres of the polder were rented to local farmers; they obtained satisfactory yields. In the new extension polder, five test plots gave variable but fairly satisfactory results; in addition, 13 acres were rented, the farmers obtaining reasonable yields. This extension is not yet completely cleared of mangroves and the drainage system is not complete. If conditions are comparable with the original polder, yields should improve considerably in the

next few years. Three trial plots outside the polder failed badly, the river was only fresh for the three months of August, September and October. The results as a whole are most encouraging; the local farmers are taking a keen interest and are prepared to pay rent for plots within these polders.

90. *Wellington.*—A further 24 acres were allocated to farmers in 1949 in addition to the original 10 acres rented in 1948. The original plots showed an improvement in yield over 1948, giving an average of 1,370 lb. padi/acre, but the new plots were not satisfactory, averaging only 530 lb./acre. Rainfall was badly distributed. Conditions have not yet been provided to give satisfactory results over the whole of the area. Measures to remedy this are in progress.

91. *Oil-Palm Plantation, Waterloo.*—A proposal to establish an oil-palm plantation on the airfield at Waterloo (excluding runways) was accepted by Government and the initial work of establishing a nursery for raising seedlings was started in August. A pump was installed to provide water for the nursery and by the end of the year some 14,000 seedlings had been established in nursery beds. A large quantity of seed of Deli Palm was sown in germination beds. It is hoped to begin planting in 1950.

92. In addition to the work on the poldered areas, considerable assistance and advice to pig-keepers in the Colony was given; several have done very well and they find a ready market for their pigs in Freetown, selling usually to the Cold Storage Company. Assistance to the hill village market gardeners continued, and other extension work in the Colony villages of the Peninsula has been intensified with a view to increasing the productivity of these people to meet the increasing demand for locally grown food crops. In the Colony, 252 bushels of good seed rice were distributed to farmers during the year. The distribution in Koya Chiefdom has been undertaken by the Native Administration but has not worked very well.

(*c*) RESEARCH

Plant Pathology Section

93. The Plant Pathologist, Mr. F. C. Deighton, O.B.E., reported as follows:—

1. "The Plant Pathologist returned from leave on April 2nd, 1949. Mr. C. T. Pyne, Laboratory Assistant, proceeded to the United Kingdom in September, to take up a scholarship to read for an Honours Botany degree at Cardiff, and the vacancy thus caused was not filled by the end of the year.

2. This was the first year since 1939 in which the Plant Pathologist has had more than two or three months of uninterrupted work in his substantive post. It was therefore necessary, as a start, to get the herbarium and records in order, and two more herbarium cupboards were made locally. A draft revised list of Sierra Leone fungi and plant diseases was prepared, in the course of which it was apparent that several common local parasitic and especially saprophytic fungi had not yet been identified or were poorly represented in the herbarium. Attention was therefore given to filling these gaps, and by the end of the year over 1,000 collections of fungi had been sent to the Commonwealth Mycological Institute, duplicates being placed in the herbarium at Njala. A number of collections of *Cercospora* were made, especially on moribund stems and leaves of plants, preparatory to a study of this genus in Sierra Leone.

3. The Plant Pathologist continued in charge of the Departmental phanerogamic herbarium (in which is incorporated the Forestry herbarium), and during the year nearly 500 collections (three-quarters of these by other members of the Agricultural Department and by Forestry Officers) were sent to the Royal Botanic Gardens, Kew, duplicates being placed in the herbarium at Njala. Attention was particularly given to some of the common weeds of the country whose nomenclature was confused in the past, and to certain plant families such as the Marantaceae which are not well known from Sierra Leone.

4. A large vernacular vocabulary of plant names was prepared from notes collected during the last twenty years, but owing to shortage of typists it remains in manuscript draft.

5. A short visit was paid in October to Gegbwema (Tunkia), and another in November to the Pujehun–Potoru area.

6. *Cow-pea* (*Vigna sinensis*).—Teleutospores of the cow-pea rust were observed for the first time in Sierra Leone on a native variety of cow-pea at Bo in April, 1949. Dr. G. R. Bisby of the Commonwealth Mycological Institute has identified the fungus as *Uromyces vignae* Barcl. He has also re-examined the Sierra Leone gatherings of the common and very similar rust on the wild *Vigna venulosa*, previously thought to be *Uromyces vignae*, and has now identified this as *Uromyces pazschkeanus* P. Henn. *U. vignae* seems to be a rare fungus in Sierra Leone.

7. *Rice*.—The disease caused by *Ephelis pallida* Pat. (*Balansia* sp.), which first appeared (*see* Annual Reports for 1946 and 1947) on Fortuno, Sagbama, Konko and Atebubu rice varieties at Rokupr towards the end of 1946, was present again there in 1947 on Sagbama, Konko and Atebubu but not on Fortuno. In 1948 at Rokupr it attacked none of these four varieties but appeared on Kavunginpoothala and on PTB. 15 (which may be a selection of Kav.). In 1949, Kav. and PTB. 15 were free from the disease at Rokupr and none of the other varieties attacked in previous years was grown there. Atebubu was sown at Rosino in 1949 from Rokupr seed, and was attacked. Fortuno, Sagbama, Konko and Atebubu were grown on small upland plots at Njala in 1949 from Rokupr seed and, though none of them grew well, they all remained free from *Ephelis*.

8. During the year, several more records were made of *Ephelis pallida* with its *Balansia* state, on wild grasses, including *Panicum laxum* Sw. (the first record on this host) at Njala. The fungus was seen particularly commonly in 1949 on *Panicum dinklagei* Mez. in the southern chiefdoms of Jaiama, Tunkia and Peri.

9. The Agricultural Officer, Rokupr, has supplied the following notes on incidence of *Piricularia oryzae* attack (" scorch ") on seedlings of rice varieties grown at Rokupr Agricultural station in 1949:—

(*a*) severely attacked:
Kav. selections: 12, 22 and 64.
French Guinea rices: Sin Gbeli and Safikile.
Local rice: Yaye.

(*b*) moderately attacked:
Kav. selections: 8 and 30.
Indo-China selections: 20 and 22.
Local rice selections: Lal 10 and 22; Bis 101; Toma 256.
Imported rices: PTB. 15; Kurulutuduwi; Gopalbhogue; Co. 7/75; G.E.B. 24; Sughandi; Tai Chu; Chines; E.A.N. No. 3 and No. 6.
Local rices; Wala; Kundi; Patei; Gbagbagomei; Gbawai; Gobei; Miatomei; Kinkin; Ben Salay; Njari Bomboi.

10. *Maize*.—Rust (*Puccinia sorghi* Schw.) had not been recorded in Sierra Leone till October, 1943, when a few lesions were seen on a leaf received from Bo. In 1949 it was widespread in Sierra Leone, probably occurring throughout the country; and during the exceptionally wet months of July, August and September at Njala this year the rust caused severe damage to the maize crop then in flower: some short season varieties were so severely attacked at Njala as to be stunted, and few cobs matured. The disease caused little damage on the dry season crop, though rust was present on older leaves of the plants, and it seems probable that it will only be serious during exceptional wet weather. It is probable that maize rust was introduced to Sierra Leone some time between 1940 and 1942.

11. *Onion* (*Allium cepa*).—Onion bulbs grown at Newton Agricultural Station and received at Njala in April, 1949, frequently exhibited an irregular dark zone round the neck-end extending from the cut ends of the leaves to an inch or more down the outer scales. White onion varieties were more commonly and more severely attacked than red or brown varieties. Between the outer scales, grey-brown rather woolly sclerotial bodies were seen, and the discoloured portions of the scale-leaves were full of coarse brown fungus mycelium. On one onion, pycnidia were situated on the outer scales over each of the sclerotial bodies. Other bulbs produced pycnidia in a few days when kept in a moist chamber, both on the outside of the bulb and in the sclerotial bodies between the scales. The fungus was *Botryodiplodia theobromae* Pat. In addition, the bulbs kept in the moist chamber rapidly became covered, from the neck-end downwards, with *Aspergillus niger*.

12. Difficulty had been found at Newton in getting the leaves to dry off properly after harvest. The onions had been tied by their leaves into strings, after harvest, and hung up: but after three weeks the leaves showed no sign of drying properly (and, in fact, new leaves were appearing), and they were cut off. It seems advisable to grow brown or red rather than white onion varieties in Sierra Leone.

13. *New Records* include:

Isariopsis griseola Sacc. on leaves of *Phaseolus vulgaris* at Njala in May, 1949: probably a recent introduction. *Uredo ignava* Arth., common on the indigenous bamboo *Oxytenanthera abyssinica* but not on the exotic Bamboo *Bambusa arundinacea*. *Puccinia cynodontis* Desm. on. *Cynodon dactylon*. *Uromyces tenuicutis* McAlp. on *Sporobolus pyramidalis* *Monilia* sp. common on freshly fallen ripe fruit of *Scytopetalum tieghemii* at Njala in September–October. *Botrytis* sp., near *Sclerotnia ricini* Godfrey, abundant on catkins and to a lesser extent on leaves of *Acalypha hispida* at Njala in July–August, but not on varieties of *Acalypha wilkesiana* growing nearby; the same species has been recorded on *Acalypha* and *Phyllanthus* from Gold Coast. *Sclerotium coffeicola* Stahel, causing leaf spot of *Aristolochia gibbosa* at Njala, where this fungus is always common on *Jasminum pubescens*. *Aspergillus melleus* Yukawa, growing on the outside of locally made cheroots from Makeni in September.

A number of new records of saprophytic fungi on dead wood and leaves were also identified by the Commonwealth Mycological Institute, and Mr. H. J. Howard has kindly identified about 20 myxomycetes from Sierra Leone.

Entomological Section

94. The Entomologist, Mr. F. A. Squire was on vacation leave from September 1st; he reported as follows:—

Crop Pests

" 1. *Cacao*.—Two stem borers—the Lamiid beetle *Tragocephala nobilis*, Thoms. and the megalopygid moth *Eulophonotus myrmeleon*, Feld., were both bred from specimens of dead branches from the Pujehun District in November and December. The girdler beetle *Diastocera trifasciata*, F. was recorded from Kenema in May as a pest of cacao trees for the first time in Sierra Leone.

2. *Rice*.—Infestations of the 'Army Worm' *Laphygma exempta*, Wlk., were widespread in May and early June. On the whole, however, not much damage was reported done to rice, sowing having just begun.

3. *Coffee*.—The long-horned beetle *Bixadus sierricola*, White (Lamiidae) bore into the stems of coffee in various parts of the country. An article on its life-history and control was published in the popular press in March for the benefit of farmers.

4. *Yams.*—A Dynastid beetle *Prionoryctes breviusculus*, Arr., was recorded as attacking water yams (*Dioscorea alata*) tubers in Bonthe, and in Jaiama and Bagbo Chiefdoms in the Bo District. As Dynastids breed in decaying vegetable matter the source of infestation is most likely the manure used in manuring the yam heaps.

5. *Fruit Piercing Moths.*—These destructive pests of citrus, mango and other soft fruits, were very active in May and June. Thousands of caterpillars could be seen on their regular host plants around Njala, some of which were completely defoliated.

6. *Zonocerus variegatus*, L.—This well known grasshopper was very scarce during last dry season (October to December). Around Njala this may be attributed to the effects of digging up eggs during the past two breeding seasons, but it does not explain the cause of its scarcity in other parts of the country.

Timber Pests

7. Specimens of beetles attacking timber were received from Kenema, Bo and Freetown for identification. Among those identified by the Commonwealth Institute of Entomology are the following species new to Sierra Leone:—
Tarsostenus univittatus Rossi (Cleridae) and *Lyctus africanus*, Lesne (Lyctidae).

Light Trapping of Insects

8. The nightly collections of insects by means of a light trap was continued, thus completing the third consecutive year of light trapping. The results demonstrate a marked seasonal distribution of incidence. In addition, the interesting relationship between the numbers of species and individuals is being investigated.

Tsetse Fly Investigations

9. A new aid to the study of the bionomics of the fly was worked out and a paper on this subject published. A marked seasonal variation in the trypanosome infection of *Glossina palpalis* was demonstrated.

Reference Collection

10. Out of a total number of 144 species identified for us by the Commonwealth Institute of Entomology 68 were new, and these have been added to the Reference Collection."

Agricultural Chemistry Section

95. The following is a summary of the Agricultural Chemist's report, the full text of which is published as an appendix:—

Staff.—The Agricultural Chemist, Mr. H. W. Dougall, returned from leave at the end of April, 1949. Mr. J. O. Belford, Laboratory Assistant, proceeded to the United Kingdom in August to read for a degree in Pure Science at Leeds. The vacancy thus caused was not filled during the remainder of the year; this, with the other vacancy for Laboratory Assistant still unfilled, seriously handicapped the work of the Section.

Scope of Work Undertaken.—The programme of work included—modifying certain practical measures already taken in relation to the reclamation of deltaic and littoral swamp soils for the production of rice; attempting a preliminary assessment of their normal crop-producing capacity and their productivity when fertilizers are used and preparing a provisional classification of the soils; field experiments with fertilizers with the object of obtaining an estimate of the productivity of some different soil types when rice, legumes and sweet potatoes are grown; preliminary and empirical studies on the role of fertilizers in establishing nursery oil-palm seedlings and in the establishment and management of pastures; occasional soil reconnaissance surveys in connection with soil classification and present land usage.

Soil Reclamotion Projects.—Rosino.—A geological survey of the area was carried out by the Director of Geological Surveys and has provided most valuable data. The swamp was divided by the construction of a bund across it which would define two separate areas which could be treated in different way.

(*a*) a frontal area capable of being conveniently and adequately irrigated by tidal inundation.

(*b*) a rear area, which comprises zones of seepage and marshland not subject to tidal inundation, from which river water can at all times be excluded.

The bund was provided with adequate sluices to ensure the necessary water control. In the frontal area the number, size and depths of all ancillary drains were increased to improve the efficiency and speed of irrigation and drainage.

Construction work started in the 1948–1949 dry season, but until July 1949, the frontal area could not be irrigated from the river. Several test plots of rice were transplanted late in July but pH values of the drainage water indicated that the soil was still inadequately leached. Fertilizers were used—though prematurely. The evidence from these test plots indicates that phosphatic and nitrogenous fertilizers are likely to be of value.

In the rear area, no definite programme of work has yet been formulated; the vegetation is changing from a marshland type towards a grassland, with the possibility that the grass may ameliorate soil conditions considerably.

Rokupr Rice Station.—The return to unrestricted tidal inundation of those plots which were empoldered and controlled in 1944 (with subsequent denial of flooding) has resulted in a considerable improvement in fertility.

The improvement in soil conditions for the growth of rice in the 4-block polder is illustrated in the following table, where yields are expressed in pounds/padi per acre:—

Block Number		10	11	13	14
	1949	2,020	1,440	2,625	1,640
1st Year of Modification	1948	540	288	1,320	15
YEAR	1947	1,020	162	2,016	0
	1946	1,770	1,302	2,550	210
	1945	2,100	1,458	2,298	432
1st Year of Poldering	1944	3,180	2,280	2,736	2,172
Average	1938–43	1,548	1,326	1,812	1,572

Reclamation of Saline Soils.—Wellington empolder.—Work on the reclamation of this empolder has progressed and a larger area of land is now being cropped by local farmers; unfortunately the second sluice, an essential part of the modified drainage system, had not been installed by the end of the year. The beneficial effect of the lime applied in 1948 was again very apparent on the growth and development of the rice on the plots to which it was applied; it is becoming apparent that the lime not only ameliorates acidity but renders an impermeable soil more permeable.

Soil Fertility Problems.—A series of experiments, some started in 1948, were continued during the year. These include:—

(*a*) Modification of local native practices by including leguminous cover crops grown through the rice crop; the legumes were groundnuts, *Tephrosia candida* and *Pueraria phaseoloides:* the last two subsequently becoming cover crops in the succeeding years although not being allowed to interfere with the subsequent test crop of cassava,

(*b*) Use of leguminous fallow crops; by establishing Pueraria and Tephrosia with the assistance of farm yard manure and phosphatic and nitrogenous fertilizers. At fortnightly intervals during the first six months of the year, determinations of moisture and nitrogen content of air dried soil were made. Total nitrogen content of Pueraria leaf was also determined.

(*c*) Use of tree fallows. The study started in 1948 was disappointing, only *Gmelina arborea* established easily; the others, *Terminalia ivorensis*, *Tarrietia utilis* and *Sarcocephalus diderrichii* failed despite the use of compost and fertilizers. In 1949, Cinnamon and Tarrietia were used with indifferent results; the Gmelina continued to grow vigorously.

(*d*) Use of grass covers. Both at Newton and Njala, trials were carried out to determine the value of different forms of phosphatic and nitrogenous fertilizers in correcting soil nutrient deficiencies in order to establish good stands of grass. Potash where applied was in the form of the sulphate. Earlier and more vigorous growth was evident after the use of fertilizers and the useful grazing period was lengthened and an early bite obtained in the following year. A late application of sulphate of ammonia in September favours a late production of leafy growth for grazing and cutting.

Fertilizer experiments.—A considerable number of experiments under various conditions of soil and with various crops were carried out during the year. Experiments with rice indicate that in general the phosphate status of the soil is of first importance and that superphosphate was preferable to silicophosphate when used with nitrogenous fertilizers, and calcium cyanamide was in general more effective than sulphate of ammonia.

With sweet potatoes, compost with a full N.P.K. mixture added gave a considerable increase in yield over the control and indicated that superphosphate was the more appropriate phosphatic manure when compared with ammophosphate.

Small experiments in the use of fertilisers on nursery beds used for oil-palms were also initiated.

Soil Surveys.—Reconnaissance soil surveys were continued and a consider able amount of most useful data collected.

(*d*) PRODUCE INSPECTOIN

96. During the year the staff was increased from 32 to 34 by the appointment of a second Inspector of Produce—Mr. C. G. White—and a second Assistant Inspector of Produce. The staff was still inadequate to maintain inspection at all important market centres and three had to be closed down (Mattru, Yonnibana and Kambia) until further staff becomes available. In addition, further types of produce have been included in the list of those required to be examined before export; this has thrown extra work on to a staff already fully occupied. In November, this branch, which was formed in 1922, passed to the control of the Department of Commerce and Industry.

97. The main work of the staff was the inspection of palm kernels, piassava and ginger; towards the end of the year, full inspection of cocoa was instituted in accordance with the new rules; groundnuts, benniseed and coffee were also examined for gross adulterations although no legislation has yet been drawn up as to the minimum standard required for export. Bananas were also required to be examined before export to see that exporters complied with the terms of the contract with the Ministry of Food.

98. In general, the quality of exports has been well maintained throughout the year. One complaint regarding palm kernels was received from the United Kingdom, but the sample sent for re-testing came well within the prescribed limits of impurity. Piassava continued as the most troublesome of all produce; the institution of only one classification for export, i.e. Standard Quality, on the advice of the Piassava Advisory Committee, settled some grievances, but the differential sealing of Sulima and Prime Sherbro was maintained for those who so wished. The quantity of Prime Sherbro shipped declined somewhat during the year; the quality of Sulima type showed a definite improvement. The opening of Sulima as an export port has given satisfaction to the trade in that area.

99. The institution of cocoa inspection and grading necessitated examiners being posted to the producing areas. The price differential for various grades resulted in a lower price being offered for low grade cocoa compared with the previous year. Although the quantity of high grade cocoa was small, the condition of the bulk of the crop was a big improvement on that of previous years.

100. Inspection and certification of produce stores before the grant of licences was instituted towards the end of the year, with particular reference to piassava storage. It is hoped that by this method the standard of cleanliness and condition of stores will materially improve in the future, a very necessary requirement for the maintenance of good quality in produce.

(*e*) AGRICULTURAL EDUCATION

101. The training of potential Agricultural Instructors continued at the Njala Training College. The agricultural side of the courses was in charge of Mr. T. P. Wheldon for the first four months when Mr. G. C. Taylor took over; Mr. J. A. Austin assisted during the early part of the year, up to mid-April. The following resumé of the year's work is extracted from the Principal's annual report for 1949: –

> " Sixteen Agricultural Students were in training during the year. Of this number eight were in the 4th year and eight in the 2nd year of their course. In April, the 4th year students completed their three and a half years College course and in May, were posted to Agricultural Stations for six months field training under Agricultural Officers. Recruited in 1946, this group completed their four-year course of Agricultural training in November, 1949. The Second year students recruited in 1948 were in residence throughout the year and received lectures in English, Mathematics, Crop Husbandry, Agriculture, Agricultural Botany, Ecology, Nursery Practice, Surveying and Zoology with special reference to anatomy and physiology of farm animals.
>
> A considerable amount of practical work was done by the students on the College Farm and Nursery. Two hundred young fruit trees including citrus, mango and avocado pear were budded. Twenty oil-palms and 28 budded-grapefruit seedlings received from the Agricultural Officer, Njala, were transplanted on the fourth permanent strip. Three hundred sour orange seedlings were raised to supply material for budding practice. Two hundred and fifty bud-woods of citrus were supplied to the Departmental Nursery, Njala, and about 6,000 grapefruit and lemons were distributed. The Departmental Nursery was visited several times for observation and practice in budding and grafting. A large collection of economic and ornamental plants were identified and 40 specimens of these plants were planted in the College Nursery. Fifteen compost heaps were made. The vegetable gardens were extended and throughout the year, fresh vegetables were available for the students' mess. Much time was spent on the departmental farm where assistance was given by the students in contouring and terracing. A chain and compass survey was made of the Gbongeima and Mokonde swamps and maps of these places were drawn to scale by the second year group. At the end of the year the students were engaged in making a detailed survey of the Njala residential area.

In the livestock section of the College farm, the rearing of calves was continued. A piggery was established with young gilts supplied by the Agricultural Officer, Njala. They were returned for mating in October in good condition. In November, three gilts were received from the Agricultural Officer, Njala. The poultry flock was maintained and until November the production of eggs was fairly good. In December the runs were removed into the arboretum owing to their close proximity to the site of the new domitories.

As it was not possible to arrange a tour of instruction to other agricultural stations for the second year students, each member of this class was given a special economic or ecological subject for investigation in the Kori and Dasse Chiefdoms. The reports submitted were fairly satisfactory. In their botanical study of crops, the students were encouraged to collect seeds of economic plants. The seeds collected were mounted and submitted to Mr. G. W. Lines, Deputy Director of Agriculture, who very kindly awarded prizes to the three best seed-collectors of the class.

The students were also given the opportunity to carry out two field experiments using upland rice as the test crop. One experiment taught them that yields of rice may be expected to vary with (i) the variety of rice which is planted and (ii) the method of planting. They showed that the traditional method of broadcasting different varieties of seed rice gives yields inferior to the same varieties when they are dibbled. The second experiment introduced them to the recognition of fertilizers, the method of their application and their subsequent effects on yields of rice."

102. As this is the last time that I shall sign this report I wish to take the opportunity to place on record my sincere appreciation of the very loyal assistance and service which I have received from all my colleagues in the Department of Agriculture, both senior and junior service staff, throughout my tenure of office. I am grateful too for the help and encouragement so consistently and readily given to me and to my staff by the Administration and those other departments on whose co-operation the success of the Department of Agriculture depends so much.

R. R. GLANVILLE,
Director of Agriculture.

DEPARTMENT OF AGRICULTURE,
NJALA,
via MANO

APPENDIX

AGRICULTURAL CHEMISTRY SECTION

The Agricultural Chemist, Mr. H. W. Dougall, reported as follows:—

1. At the end of April 1949, the Agricultural Chemist resumed duty on the expiration of his leave. In August, Mr. J. O. Belford, the only Laboratory Assistant, departed for England to read for the degree of B.Sc. in Pure Science in the University of Leeds. Thus two vacancies for Laboratory Assistants now exist but no suitable candidates are yet forthcoming to accept them. The lack of assistants is very seriously affecting the normal functioning of both field and laboratory work alike and at the present time there seems little prospect of the situation improving.

Scope of Work Undertaken

2. The programme of work included modifying certain practical measures already taken in relation to the reclamation of deltaic and littoral swamp soils for the production of rice; attempting a preliminary assessment of their normal crop-producing capacity and their productivity when fertilizers are used and preparing a provisional classification of the soils; field experiments with fertilizers with the object of obtaining an estimate of the productivity of some different soil types when rice, legumes and sweet potatoes are grown; preliminary and empirical studies on the role of fertilizers in establishing nursery oil-palm seedlings and in the establishment and management of pastures: occasional soil reconnaissance surveys in connection with soil classification and present land usage.

3. Details of the work undertaken during the year follow hereunder:—

Soil Reclamation at Rosino

4. It may be recalled that in the Annual Report of this section for 1948, attention was directed to the absence of geological and other essential data necessary in planning this irrigation project. The need for at least a surface-geology survey became imperative in light of a soil survey which clearly revealed the presence of a ground-water laterite formation at the intersection of the main drain of this project and two of its lateral, ancillary drains. It was obviously desirable that the extent of this formation should be known before any further work of a constructional nature could be contemplated. During late March and early April therefore, the Rosino reclamation area was examined by the Director of Geological Survey—Mr. J. D. Pollett—who sunk a line of boreholes at 300 feet intervals across the swamp and along the general line of the two ancillary lateral drains mentioned above. The Geologist's report is valuable in providing a clear exposition of the geology and geomorphology of this area and it is quoted, almost verbatim, below:

5. The higher ground surrounding the swamp was found to consist of lateritised residual weathering products together with some quartz debris, formed from gneissic rocks of the Pre-Cambrian Kasila Series. The data obtained from the line of boreholes showed that the swamp consists of river alluvial material lying on soft, weathered biotite granitic gneiss. The greatest thickness of alluvium was found at the centre of the line of boreholes, where soft gneiss was met at a depth of 44 feet. The surface of the swamp consisted of black powdery peat and humus to a depth of a foot or more. This rested on grey river clay-silt, which contained some carbonised mangrove roots and wood in the top six feet. A sample of the grey clay, when washed and exposed to the atmosphere for a few days developed a white scum on its outer surface. (This material has been shown to consist of ferrous and ferric sulphates, but mainly the former in the form of $FeSO_4.4H_2O$, which is the most stable hydrate). Numerous gastropod shells of the genus Cerithium were found in the clay at depths varying from 15 feet to 22 feet from the surface. However, as very similar shells can be found in mangrove swamp areas in this country at the present time, their presence are of doubtful assistance in determining the age of the deposit.

6. The clay bed becomes considerably more sandy in depth and pebbles of quartz, limonitic material, gneiss (not common) and of hard silicaceous cemented sandstone were found in several of the boreholes. There is however, no definite dividing line between the clays and deposits of larger particle size and some clay was found in most of the holes until bedrock, consisting of soft, decayed biotite granitic gneiss, was reached. The boundary between the clay and more sandy beds, when shown diagrammatically in section, is a tentative one.

7. Laterite outcrops were encountered in the main drain near to and at its junction with two ancillary, lateral drains, together with laterite gravel mixed with red and grey clay, at a depth of 5 feet. At 15 feet, some of the clay showed traces of gneissose structure and it is probable that it is derived from softened partly lateritised decayed gneiss. Soft decayed biotite granitic gneiss was met at 23 feet, but the actual boundary between the bedrock and the overlying alluvium is not clearly defined and it is desirable to show a transitional zone in a section diagram. This part of the swamp lies in line with a spur of high ground at the junction of the northern boundary of the branch swamp with the main Rosino swamp. It is probable that most of the laterite gravel has been derived from this spur and its continuation beneath the swamp.

8. The boreholes sunk near the junction of the main drain with the Great Scarcies river disclosed a thickness of 37 feet of a grey silty clay resting on soft black and white decayed biotite granitic gneiss. The upper 15 feet of the clay contained root remains and carbonised wood and the last 22 feet were more sandy in character. Another borehole was sunk several hundred feet to the west of the last mentioned, and close to the junction of a creek with the main river. The hole was still in river sediments at 53 feet, when it had to be abandoned. The first 25 feet of clay contained roots and carbonised wood and the remaining 28 feet were more sandy. A little river gravel was met at a depth of 30 feet and more sand and gravel occurred interbedded with clay during the remainder of the hole.

9. The heavy material concentrates from the holes along the main swamp section were noteworthy chiefly for the presence of plentiful purplish-brown and reddish-brown rounded grains and grain aggregates.

On analysis this material was found to consist mainly of ferrous carbonate (siderite, containing 43 per cent Fe). Calcium, Magnesium and Potassium were also present, the former, as carbonate, constituting 1.8 per cent of the sample.

10. It is believed by the Geologist that the swamps which constitute the present land-forms at Rosino and adjacent areas appear to be drowned river valleys filled in by river clays and silts. In this connection he quotes R. A. Daly, an American Geologist, who has drawn attention to the fact that the melting of the ice locked up in the Continental ice-sheets of Europe and North America during the last ice age restored to the oceans water previously abstracted, and it has been calculated that during the height of the glaciation the level of the oceans must have been about 300 feet lower than to-day. It is about 25,000 years since the last retreat of ice cap. Applying Daly's hypothesis, it can be suggested that as the level of the sea began to rise it dammed back the river and caused it to overflow its banks and deposited its silt and mud over its flood plain and along the valleys of its tributary streams. The rate of deposition probably kept pace with the rate of rise of the sea-level and no marked encroachment of the sea over the land occurred. The tributary streams would be dammed by the deposits laid down in the lower courses, and at the present time it is asserted that their upper courses consist of deep water channels.

11. The catena at Rosino can be represented diagrammatically and is shown hereunder:—

VEGETATION

Secondary Forest regrowth	Hydrophilous Marsh Grassland	Mangrove Woodland

Great Scarcies River

SOIL

Residual Laterite Gravel Erosion Remnants, Pale Brownish-Grey and Moderate -Brown Earth rich in Gravel	Pale Brownish Grey and Colluvium	Peaty Humus Overlying Pale Blue-Grey Silt Clay Gleyed Alluvial soil	Deep Brownish Grey silt clay Over Pale, Blue Grey-Alluvial Soil-Gleyed

ENVIRONMENT

Stream-Dissected Higher Ground	Seep Zone	Non-tidal Flats—Marshland	Zone of Tidal Inundations (Flood Plain) Seasonally Fresh and Saline Waters

PROPOSED LAND-USE

Citrus Timber Oil Palms	Rice nurseries vegetables bananas, etc.	Upland rice Fibre crops subsistence crops, etc.	Rice

12. It will be recalled* that under the conditions which prevailed last year, the whole of the Rosino polder could not be irrigated naturally by the tidal inundations of fresh water carried in channels from the Great Scarcies river. Thus, in order to conform in a practical way to the limitations imposed by attempting natural irrigation-agriculture, it was decided to treat Rosino as two separate areas as follows:

(i) a frontal area which is a zone capable of being conveniently and adequately irrigated.

(ii) a rear area which comprises zones of seepage and flats not subject to tidal inundation and from which river water can at all times be excluded.

13. To effect this division a bund was constructed across the swamp along a line conveniently selected and believed with a fair degree of certainty to be a reasonable boundary between the two areas (*see* soil catena diagram above). Parenthetically, it is of interest to record here that the series of boreholes sunk by the Geologist during his examination of this area, were made along the line of this bund. A series of box sluices were installed where the bund coincided with the main drain i.e. in the area of the ground-water laterite formation. In order to encourage efficiency and speed in the irrigation-drainage relationship in the frontal area the number, size and depth of all channels ancillary to the main channel were substantially increased. The hydrological principles underlying these modifications consisted of:—

(i) denying the flow of irrigation water (via the main drainage channel) to the rear area by closing the sluices on incoming tides and thereby allowing a greater volume of water to inundate the frontal area.

(ii) opening the sluices on receding tides to drain rapidly and effectively the rear area of surplus rain and seepage water.

(iii) surplus inundation water in the frontal area being efficiently disposed of through drainage channels on receding tides.

*Throughout this report the * indicates references contained in the 1948 report.

14. The climatic norm of the frontal area has been, at a recent stage, a hydromorphic alluvial soil (the word alluvial here connoting the parent soil material) of a river's flood plain under mangrove woodland. The mangrove has been cleared to make way for rice cultivation, but the soil does not begin to loose its identity until the transition to the rear area is approached. In the rear area the climate-dictated norm has been a hydromorphic humic-gley alluvial soil under marsh vegetation. Under man's direction it is being drained and aerated (reclaimed) from the excessive influence of climate on soil. The changes in the natural vegetation succession promoted by the amelioration of the dominating influences of excessive moisture and inefficient aeration are reflected in the following records:—

1947	1948	1949
Eleocharis plantaginea	Eleocharis plantaginea	Cyperus zollingeri
Fuirina umbellata	Xyris spp.	Paratheria prostrata
	Fuirina umbellata	Panicum parvifolium
		Axonopus spp.

15. An examination of the catena diagram above shows the relationship which exists between the tidal flats (frontal), the grassland, the seep zone (rear), and the bordering higher land. It also indicates the systems of agri culture which have been evolved, or are being investigated, in order to adap- an orderly pattern of land-usage in relation to soil, climate and topography.t

16. In this scheme, the frontal area is being developed for rice cultivation under a system of natural irrigation-agriculture. The devices employed e.g. the construction of waterways and slucies etc. necessary to obtain effective irrigation and drainage have already been described and from observations made this year they appear most adequate to achieve the purpose. The necessary constructional work occupied the entire 1948–1949 dry season and until July, 1949 the frontal area had to remain non-irrigated. The land was therefore denied the periodic inundation of saline river water during the dry season and the normal, concomitant exchange of bases between the saline waters and the acid soil, could not take place. From July onwards, it was possible to begin to operate the desired conditions of natural irrigation-agriculture and the land could daily receive tidal inundations of river water in addition to the volume of rain falling directly upon it. Several test plots of rice were transplanted late in July, but the pH values of the drainage waters (4–4.4) indicated that the soil was still inadequately leached. Fertilizers were used—though prematurely—with the object of attempting to obtain an indication of what factors—(other than attaining desirable leaching)—may control fertility in relation to the growth of rice. Under the conditions of one field experiment, which is described later in its appropriate section, the evidence now available indicates that phosphatic and nitrogenous fertilizers should be of definite value in assisting growth and maturity of this crop.

17. The development of a land-use programme in the rear area is as yet in a preliminary stage. It has been reported above that in this area, hydrophilous marsh grassland had been replaced by grassland. Under the marsh grassland conditions, which formerly prevailed humification of plants and plant residues took place in an acid medium of low base status, where oxygen supply had been very restricted or entirely absent. Such conditions caused the formation of, and eventually led to the accumulation of peaty humus. Drainage and cultivation, by inducing better soil aeration, have created conditions which generally favour a rapid oxidative form of plant decomposition. Thus, of the many problems now facing the agriculturist at Rosino, one of first importance is how to establish a connection between the peaty humus horizon which formed under less favourable conditions and the pale grey, gleyed clay soil underlying it, in order to provide a basis on which a productive yet conservative land-use programme can be planned.

18. The natural vegetation succession referred to earlier may provide the clue necessary to the solution of this particular problem: it might well have even wider application, especially for the two or three years following a similar reclamation project under identical conditions. The clue is Grass. As a residue producer under conditions unfavourable to agriculture, it has to date caused only the accumulation of peaty humus. But, under favourable conditions, grass can perform functions other than the production of residues, and benefit the soil in which it is growing. It can for example, act as a circulater of plant nutrients. But it is the physical effects of its rooting system in the process of soil reconstruction which commends itself in this case. For if the roots of the grasses which compose the natural succession are sufficiently numerous and can tiller beyond the range of the humic horizon, they may be capable of producing, in time, a granulated soil in which the humus and the silty-clay below it become crumbed together in water-stable aggregates. In this way, an indigenous sward might be used to develop a desirable soil-structure and at the same time preserve the soil unexposed to the agencies of climate, It is of course possible that the rooting system of the sward as it is constituted at present may not be capable—or may only be partially capable of fulfilling the work desired of it. It may be necessary to explore the possibilities of introducing more deeply rooted grasses in order to establish an efficient resting fallow and all the beneficial effects usually associated with it.

19. Advocating the use of grass fallows in the circumstances related lends to the agriculturist a freedom of action in soil management which is not otherwise easily obtained. For example, this year, a variety of subsistence crops e.g. cassava, upland rice and sweet potato, a perennial crop—sugar cane, and an economic plantation crop—oil-palms—were planted on a very modest scale in land which had been tractor-ploughed. From the time of planting to the end of the year the soil remained cloddy where it had been exposed and not even the weight of 115 inches of rain could crumble it. Farm implements were not competent to do the work, with the result that tilth, so very desirable, was never obtained; a different story could perhaps be told had a period under grass fallow been allowed to elapse, during which time cohesion may be diminished and soil structure (a precursor of tilth) may be reconstructed under the physical influences of its deep-rooting system. Could not a system of soil management be thus evolved whereby machinery may be taken around the area *after* grass has performed its desirable functions for the soil and whereby cultivation for crop production and resting-fallows under grass, become interdependent? Such a system would tend, beneficially, to conserve the soil and its fertility for at no time would a greater area of soil become exposed to climatic agencies than could be adequately tilled for crop-production The role of fertilizers for improving the soil's nutrient status, in promoting growth and increasing yields from arable land is of course envisaged. The introduction of cattle—or other forms of livestock, to graze the grass fallows and provide for the people protein in the form of beef or mutton may not be too Utopian in these circumstances provided adequate watering facilities can be supplied from deep-bore wells during periods of drought, and a reasonable degree of freedom against disease can be assured.

20. A land-use system in the seep zone (which extends from the bottom of the lower footslopes to the margin of the rear area) has been evolved by the local Africans themselves. It is on this pale, brownish-grey and reddish-brown colluvium that they establish their rice nurseries, cassava and sweet potato beds and occasional small banana groves. It is doubtful if their system could be profitably improved upon, and generations of inherited tradition has maintained in them a shrewd judgment on the land they cultivate. Material assistance, however is given by supplying to them proven varieties of rice and other crops and advice is offered, wherever necessary, to improve cultural techniques.

21. The higher ground above the seep area is the village site and it stands only 50 feet above sea level. The soil is characterised by the presence of residual laterite erosion remnants overlying a pale reddish-brown gravel loam Lateritic. The vegetation is mainly secondary forest regrowth, but citrus trees, mangoes, oil palm etc., are found growing where conditions are presumably favourable to them. Gardens are part of the environs of most compounds and their cultivation for root crops, legumes and vegetables is an obvious and desirable system of land-use.

22. The original scheme at Rosino envisaged only reclaiming for the cultivation of rice, the hydrophilous marsh grassland behind the river's flood plain. It did not take cognizance of Rosino as a " unit of landscape " of which the marsh grassland formed an integral part. If man contemplates reclamation or any other form of interference with soil and its local climate, it is for man to know or discover quickly what are the implications of his actions. Such knowledge can only emerge from a detailed study of the complete landscape form, its soils and their vegetation and the local climatic factors, etc. which may control them. On this knowledge a land-use programme appropriate to the conditions which prevail, can thus be formulated.

The Rokupr Rice Station

23. The major causes which promoted the infertility of the Rokupr rice soils and the methods employed towards their amelioration have already been described in detail*. The polder constructed in 1944 have been modified in 1948, (less 4 blocks) by gapping one of its perimeter bunds in appropriate places and constructing new waterways designed to facilitate speedy irrigation (by tidal inundation of river water) and speedy drainage on receding tides. The remaining four blocks, though contained within the framework of the 1944 construction are separated from it by a strong, square, perimeter bund. These blocks are surrounded by a perimeter drain and dissected by central drains. River water can be admitted (or denied) access to them by controlling three sluice gates contained in a bund which also forms part of one of the original perimeter bunds of the 1944 construction.

24. The irrigation-drainage systems introduced last year have now functioned throughout two rice-growing seasons inclusive of the 1948–1949 dry season when saline waters from the Great Scarcies River periodically inundated the land. The sluice gates of the four-block polder have remained open since July, 1948 and were only closed on few occasions to facilitate clearing drains of their silty deposit down to their normal depth of 3 feet 6 inches.

25. The improvement in soil conditions for the growth of rice in the four-block polder is illustrated in the following table, where yields are expressed in pounds padi per acre:—

Block Number		10	11	13	14
	1949	2,020	1,440	2,625	1,640
1st year of modification	1948	540	288	1,320	15
	1947	1,020	162	2,016	—
Year	1946	1,770	1,302	2,550	210
	1945	2,100	1,458	2,298	432
1st year of poldering	1944	3,180	2,280	2,736	2,172
Average 1938–43		1,548	1,326	1,812	1,572

26. The restoration of more fertile soil conditions began astonishingly quickly last year when the remainder of the blocks within the framework of the modified polder were allowed unrestricted irrigation by tidal inundations. All blocks could be irrigated quickly and surplus water drained away quickly on receding tides.

27. The Rokupr Rice Station forms part of the base-levelled flood plain of the Great Scarcies River. The soil is an organic, brownish-grey silty clay. The vegetation until about 1910, when it was cleared to make way for rice cultivation, was predominantly Rhizophora mangrove woodland. During the period 1910–1944, the soil, under the same climatic conditions, was capable of perfunctorily producing annual crops of rice with no great hazard provided the simple principle was carefully observed of ascertaining that salinity, which developed during each dry season (by a base exchange process), was removed by leaching the soil before seedling rice transplanting took place.

28. In 1944, part of the Rokupr farm was poldered with a view to denying to the soil at all times the tidal inundation waters which nature dictates it should otherwise have in its natural environment. It was expected that rice should grow as a rain-fed crop during the appropriate season and, as saline waters could now be excluded during seasons of dryness, forms of cultivation alternative to rice might perhaps be assayed. The objects at the time were attractive, and had they been successfully achieved, would have represented man's control over soil and water. But the climate as a whole was not treated with, nor were the possible effects of an interaction between climate and soil properly explored.

29. The mean annual rainfall at Rokupr for the last fifteen years is 117 inches; the weight of one inch of water falling upon one acre of land is slightly over 100 tons. As the total area of the polder was approximately 13½ acres it will be seen that during a single season over 1.5x105 tons of water fell within the polder in the form of rain. Three small sluices only were expected to clear this area of its surplus water. Thus, although provisions had been made to deny the soil inundation waters, adequate precautions were not taken to ensure that surplus rain water could be effectively removed. The effect of climate had not been treated with sufficiently and in the circumstances waterlogged conditions quickly developed and became acute. The conditions thus created promoted retrogressive soil changes inimical to the growth of rice in which ground water stagnated and became increasingly acidic. In the dry season when the soils were not in cultivation evaporation process favoured the formation of efflorescences on the surface of the soil, notably the tetrahydrate of ferrous sulphate and some ferric iron; the ratio of ferrous to ferric iron no doubt varying with humidity and temperature. Aluminium and phosphate irons were included in the efflorescences as insoluble basic phosphates of iron and aluminium formed by reduction processes in an acid medium rich in organic matter and hydrogen sulphide and in which the main reaction was the conversion of iron either as $Fe_2O_3 . nH_2O$ or $FeO(OH)$ to FeS which later became oxidised, during the dry season, to form $FeSO_4 . H_2O$, $FeSO_4 . 4H_2O$, and $FeSO_4 . 7H_2O$.

30. In 1948, after four years of declining fertility, soil management was reverted—with a success repeated again this year—to conform once again to a climatically—dictated normal. Only the four blocks already referred to were retained empoldered with a view to exploring the possibilities of rigidly controlling both soil and climate in relation to rice growth at a later date. The table illustrated above indicates that during the past two years the soils of these blocks have regained their lost fertility sufficiently to permit initiating this investigation during the coming year.

31. Small pockets of "patchy" growth have persisted this year in blocks reported on last year as supporting rice plants the leaves of which displayed intensive purple, discolouration. This manifestation was ascribed at the time to a temporary state of phosphate unavailability. A field experiment conducted last year indicated that Rokupr rice soil does in fact respond to applications of phosphatic fertilizers, and these results have been confirmed this year. It is observed that where growth is very "patchy" pockets of

reddish-brown "colloidal" material occur suspended in standing surface water. A thick film of green algae develops in this water and underlying it is a black reducing zone of varying depth, but often of several centimeters. From this zone an odour of H_2S evolves as a result of the microbiological reduction of sulphates present. Below this is the organic blue-grey silty clay of the parent material to great depth. The standing surface-water on evaporation in situ yields a residue of reddish-brown ferruginous scum several millimeters in thickness. The pH values of the standing water, determined colorimetrically in the field vary from 4.4 to 5; the pH value of the ground-water may be 4 or less. The significance of the presence of green algae in these circumstances and the biological role they play is not at all clearly understood but it does seem conceivable that one function may be the oxidation and precipitation of iron, as the hydroxide, or oxyhydroxide, from standing surface water, using for the purpose the oxygen liberated during their photosynthetic processes. Such conditions, however localised in small pockets, are nevertheless important because they are inimical to rice growth and tend to favour the appearance of acid-tolerant vegetation of the 'Eleocharis' variety. It is considered, however, that small surface-drainage channels sited and constructed to link such pockets to the main drainage system will, by improving the local site drainage, cause the reducing zone to function sufficiently below the soil to prevent as far as possible the roots of the rice plants coming in contact with it.

32. One feature noted this year at Rokupr as meriting attention was the poor condition of the seedling rice produced in its nurseries. Almost without exception, the seedlings were dwarfed, etiolated and more frequently than not manifested systems of Piricularia oryzae infection. It is not within the scope of this report to formulate possible reasons why this disease was prevalent, less so to ascribe it entirely to the viscissitudes of climate by virtue of the May rainfall (2.86 inches) compared with the mean average for this month over the past fifteen years (6.55 inches). It is the fertility of rice nurseries which comes within the purview of the Agricultural Chemist and on the visual evidence available it would appear that efforts must be made to develop routine manurial treatments whereby their fertility can be at once enhanced and continuously maintained. A lead has already been given in this direction during the year under review at Maswari in the Colony circle, with profitable results. The underlying principle in relation to this work is that, as soils are expected to grow crops of rice for us, we in our turn are responsible to the soils for endowing them, within the limits of the present state of our knowledge, with the plant nutrients necessary for their growth, development and maturity. Where transplanted rice is grown, the plant nutrient story begins at the nursery. At Rokupr rice nurseries are centred in a seep zone forming part of a catenary sequence which, beginning at the river, consists of the river's flood plain, the slightly elevated seep zone and the surrounding higher ground. From an analysis of mean yield data obtained during the period of 1935–1943, it would appear that a marked and progressive decrease in rice yields can be expected in the direction River—Seep zone. This factor must be taken into account when attempts are made to attain a standard of optimum fertility for rice nurseries prepared in this soil.

RECLAMATION OF SALINE SOILS

Wellington

33. At Wellington on the coast of the Colony Peninsula a saline, Alluvial soil has been in the process of reclamation for the growth of rain-fed rice during the past few years. Details of the problems which have arisen during reclamation, and the methods adopted to combat them have been described in earlier reports of this section*.

34. From an entirely utilitarian point of view the progress of the Wellington reclamation scheme, involving 60 acres of land, may be judged on the basis of the acreages now being cultivated by local African farmers:

Year	*Land use (acres)*
1947	—
1948	14
1949	45

From the viewpoint of attempting to complete satisfactorily a reclamation scheme however, the total acreage under cultivation cannot be used as a criterion that no problems exist at that moment or are not likely to arise in a cropping system adopted in the future.

35. It is disappointing to have to again record that a second sluice, of fundamental importance to the eventual success of the Wellington polder, still remains to be constructed. In this connection, it is not inappropriate to quote—"The desired extent of leaching was not effected and surplus rain water, seepage and surface drainage water (from the catchment area in the Colony hills behind the polder) and the leachates from the soil could not be completely drained away. Thus an essential part of the plan—i.e. the speed of drainage—did not reach maximum efficiency."*

36. Throughout the year pH values in respect of ground-water and drainage waters remained consistently low (fluctuating between four and five). Factors other than acidity which were operating included localised saline conditions and the allied undesirable soil properties of defloculation, impermeability and inefficient aeration.

37. The fundamental problems at Wellington, although in many respects remaining unchanged from last year, especially in several plots of this polder, are nevertheless not insurmountable. Much stress has necessarily been placed on the desirability of achieving maximum leaching efficiency in respect of the removal of salts of iron and sodium. What has been referred to but not yet fully investigated is the role of lime in developing the productivity of reclaimed saline soils. The action of leaching a soil of its surplus (and undesirable) salts cannot effect the absorptive complex of the clay fraction and thus a sodium soil or a hydrogen soil however well leached, will still remain a sodium soil or hydrogen soil until, by a base-exchange reaction the sodium or hydrogen on the reactive surface of the soil particle is replaced by a different cation e.g. Ca. It will be recalled that last year lime, in the form of burnt and crushed oyster shells, supplying 40 per cent CaO was applied at a rate equivalent to 10 tons per acre to small test plots with a view to ameliorating acidity. The dressing applied last year successfully fulfilled the purpose for which it was intended and it is not suprising that its beneficial effects were revealed again this year, when the growth and development of rice was stimulated much above that of plants growing alongside in soil which had received no previous treatment. There are already sound theoretical grounds, supported by abundant practical demonstration to make the assertion that the conversion of an impermeable though almost salt-free sodium soil (where such occurs) into a permeable soil can be brought about by the action of a soluble neutral calcium salt (e.g. CaS04 or CaC12) or by finely divided Calcium carbonate. In the circumstances therefore, the role of lime at Wellington becomes clearer: it can be used to ameliorate acidity and it can be used to render an impermeable soil permeable. Both desirable reactions are brought about by a base-exchange process whereby H on the one hand and Na on the other, are replaced in the soil absorbing complex by Ca. These reactions in connection with the reclamation of sea clays in Sierra Leone are yet to be studied in detail.

Soil Fertility Problems

Introduction:

38. The perfunctory application of the term "maintenance of soil fertility" is of little significance in this country (or any other) unless it is framed to describe soil, climate and environmental conditions etc. in relation to a specific crop. Thus a particular soil is fertile for the growth of upland rice only if that soil can provide for the crop the necessary plant nutrients (including moisture) in the required balanced amounts throughout its growth and maturity when other factors too are favourable. Experience has repeatedly shown that a soil which is fertile for upland rice during its first year under cultivation is not sufficiently fertile to support this crop in its second year. Nevertheless though the soil is not fertile for rice it is usually fertile for cassava and on this thesis is based the system evolved by the indigenes in this country of invariably interplanting upland rice with cassava. The latter grows to maturity after the rice is harvested and during this time the natural vegetation is reverting to re-growth forest or to grass for a recuperative period.

39. It is now accepted almost as a theorem in humid-tropical agriculture that deeply rooted trees and plants tap the small amounts of nutrients available in the lower horizons of the subsoil and restore them to surface soil through the vegetation. The merits of resting a soil under a bush fallow or a forest cover can be ascribed to the horizon of mineral humus which accumulates during the recuperative period provided sufficient time is allowed to elapse during which soil and vegetation (as an integral part of the soil system) remain undisturbed. Thus, for example, if the soil at Njala is a deeply weathered, highly leached gravel loam, lateritic, under secondary forest regrowth, it will continue to preserve its identity as such only as long as secondary forest conditions are allowed to continue uninterrupted. If the land is periodically cleared for cultivations or permanently maintained exposed for continuous crop production the climatic factors of high temperature and heavy rainfall exert their influence and induce excessive evaporation, increase the probability of mechanical losses and losses due to lixiviation.

40. It is well known, and the researches of Tuilin provide supporting data, that cultivation destroys the original loose structure of a soil. But cultivation also profoundly effects the movement of soil water and whereas under secondary forest conditions water moves gradually and continuously downwards through the soil and during periods of drought the soils dry up from the lower horizons: in soils exposed for cultivations the movement of water is reversed during all periods of drought or relative dryness and the water migrates to the surface and evaporates either from the topsoil or it is expressed through the growing crop. Not only does cultivation for crop-production (cereals, legumes, grass, etc.) on cleared land bring about a reversal of water movement therefore, but it also causes a diminution in the slender quantities of plant nutrients available in the topsoil which under conditions of secondary forest would otherwise be gradually leached to the lower soil horizons and be recirculated, via the deep rooting system of the vegetation to the surface soil, in repeated and uninterrupted cycles.

41. Sierra Leone has formed part of an ancient land mass since relatively early geologic time and has therefore been subject to denudation and erosion over long periods: rock weathering and soil formation processes have given rise to very deeply weathered and highly leached zonal and interzonal parent soil materials. In these circumstances it is of fundamental importance to the welfare of the country that systems of agriculture, aimed to increase food production without further endangering the soil, are explored in many sample areas selected as reflecting fairly well known soil and climatic types.

42. Some lines of approach directed towards finding a solution to problems of soil preservation during crop production and soil regeneration for future production are reported on below:—

Native Agricultural Practices—with Modifications (I)

43. It may be recalled that a field experiment was carried out last year on the Njala Experimental Station in which three legumes were grown in ¼-acre plots sharing the same soil as a subsistence crop (rice), and two of them, *Pueraria phaseoloides* and *Tephrosia candida* were sufficiently established to cover the soil when the rice was harvested. The vegetative material of the third legume (groundnuts) had been left to rot in situ. On the fourth plot rice was grown alone. The experiment has been continued this year in order to study the possibilities of using perennial legumes in an intercropping programme and to measure their effects on the yield of a test crop—Gold Coast cassava—which will be harvested in 1950.

44. The "Pueraria" is controlled by cutting at selected intervals when sufficient green leafy material is available for surface mulching while at the same time the creeping vines are never allowed to become tortuous enough to smother the cassava. In this way, use is being made of the leafy herbage to provide a mineral supplement from its decomposition products from above and use is being made of its rooting system to bring into circulation the plant nutrients from below. The cassava, planted at 5'x5' spacing on the flat has grown well and its leafy vegetation, together with that of the "Pueraria" supplies adequate shade to protect the surface soil both from direct sunlight and from the beating action of heavy rainfall. By the end of the year a good surface of consolidated, partly decomposed leaf-fall had been formed.

45. The "Tephrosia"—cassava plot has provided denser shade than the form of intercropping already described. On the other hand, the amount of leaf-fall produced by Tephrosia is much less than that produced from cut Pueraria. By periodically coppicing the Tephrosia in 1950, however, more green material will be added to the topsoil.

46. The remaining two plots support cassava alone. No attempt has been made to clear them of extraneous vegetation but periodic control is exercised by cutting grass and weeds etc. and letting their residues decompose in situ. As might be anticipated, the surface soil is not afforded the same degree of protection as in the case in previous treatments and soil-moisture conditions vary in consequence.

Use of Leguminous Fallows

47. An account was given in the 1948 report of this section on the establishment of Pueraria phaseoloides and Tephrosia candida with the assistance of basal dressings of barn manure together with phosphate and nitrogenous fertilizers, the primary object being to rest the soil under these two legumes in order to assess their capabilities of regenerating fertility for a specific subsistence crop—upland rice. Subsidiary objects here included the prevention or at least control of soil erosion and the assessment of Pueraria as a protein-rich fodder crop in respect to livestock.

48. For the first six months of the year samples of the topsoil were taken at fortnightly intervals from the "Pueraria" and "Tephrosia" blocks to determine moisture in the air-dried soil and total nitrogen. Total nitrogen

of the Pueraria leaf was also determined from random samples taken at the same time. A summary of the mean results is tabulated below:—

AVERAGE CONTENT OF NITROGEN PER CENT OF SAMPLES OVENDRIED AT 102°–105°C

Month	*Material*		
	Pueraria Leaf	*Pueraria Soil*	*Tephrosia Soil*
January	2.82	0.31	0.27
February	3.13	0.27	0.25
March	3.52	0.29	0.27
April	4.44	0.30	0.28
May	5.26	0.32	0.31
June	4.79	0.30	0.35

49. In July the Pueraria was cut close to the ground by applying the rather crude method of cutlassing the trailing vines. The leafy material and vines were spread over the area and allowed to decompose in situ. Regrowth was very slow in July and August, possibly due in part to the beating action of the intensive rain which falls during these two months, but from September onwards the aftermath developed quickly and at the end of the year a thick canopy of leafy herbage covered the ground.

50. The Tephrosia this year grew undisturbed and a heterogeneous surface cover of "Pueraria," "Calopogonium" and Para grass, etc. which developed, was periodically kept in check. This bushy legume however is now sufficiently established to permit a study on its coppicing powers to be started in 1950.

51 In these to two parallel studies on soil regeneration use is being made of both legum to tap and continuously circulate the available compounds in the soil in order to resuscitate mineralised humic topsoils, richer in plant nutrients and in better physical condition than they were under previous conditions of continuous cultivation. The problems soon to be faced include evolving carefully timed and suitable methods in order to incorporate the luxuriant covers of leguminous vegetation in the soil in such a way that available nitrogen and the mineral products of decomposition can be absorbed by the succeeding crop. The native hoe or the oxen-drawn plough cannot be charged with the duty of effectively and speedily accomplishing this work. A tractor-drawn heavy plough is the only practical alternative in the case of Pueraria. In the case of Tephrosia, even after a few years of coppicing, it will probably be necessary to resort to fire in order to reduce its woody vegetative material.

USE OF TREE FALLOWS

52. During the year 1948, an attempt was made at Njala to establish *Terminalia ivorensis Tarrietia utilis Sarcocephalus diderrichii and Gmelina arborea* with compost and fertilizers in order to study the possibilities of regenerating soil under specific forest tree species. With the exception of "Gmelina" which became established easily and rapidly, results were otherwise most disappointing.

53. This year seedlings of "Terminalia" and "Sarcocephalus" were not available and "Tarrietia" seedlings were in relatively short supply. The one acre block was therefore modified to include one-fourth acre Cinnamon, one-fourth acre Cinnamon with Tarrietia and the remaining one-fourth acre was allowed to revert to secondary forest regrowth from its coppiced trunks. Tarrietia and Gmelina replacements were planted in June, and compost with additions of phosphatic, potassic and nitrogenous fertilizers were used to assist in their establishment.

54. The "Gmelina" continued to grow vigorously throughout the year but the Cinnamon and Tarrietia made relatively slow progress and by the end of the year the planting of numerous replacements was found necessary. Except in the one-fourth acre which is being allowed to revert to secondary forest growth, the sward of indigenous weeds and grasses which appeared were cut periodically and the vegetative material produced was used to mulch the growing trees.

55. To study the establishment of forest trees for the specific purpose of assessing their value in the process of soil reconstruction is necessarily slow work, but it does appear that although "Gmelina" may be reasonably expected to prove a useful "fallow" tree, Cinnamon and Tarrietia are neither easy to establish nor do they make sufficiently rapid growth to meet the requirements which are sought. The particular problem of establishing tree species other than "Gmelina" at Njala is still elusive. But the problem of selecting suitable quick-growing tree species which can be established under varying conditions for the primary purpose of soil reconstruction (and subsidiary purposes of fuel and timber) is a general one calling for detailed study parallel to and of the same magnitude as that needed to elucidate the role of grass covers. Such studies would eventually lead to a categorisation of these two forms of vegetation cover in accordance with the functions they are each best fitted to perform under specific conditions of soil, climate, and environment.

Use of Grass Covers

56. The physical and chemical attributes which may be ascribed to grass covers in relation to the reclamation of swamp soil types has been referred to earlier in this report and it was evinced that the use of the natural vegetative succession expressed due regard to soil, climate and environment.

57. Exploratory work in relation to grass covers, their use and their management in upland areas in Sierra Leone is as yet very much in its infancy and experimentation has so far tended towards the accumulation of yield data and grazing potentialities (expressed in the form of cow-days) both for indigenous Pennisetums and exotic species of Pennisetums and Panicum maximum. Grassland management has therefore developed along rather narrow lines in which emphasis is laid on the bulk of fresh edible material produced per season for grazing or feeding in the form of hay: it has yet to give due regard to the broader implications of cultivating grass to benefit the soil in which it grows. The many examples of Stapledon's system of ley farming in Britain where the "plough follows grass around the farm" at appropriate intervals could be usefully assayed as an analogous system in this country, the maxim being that man must endeavour to benefit the soil which supports him and his livestock.

58. To date pastures have been developed from the propagation of grass stools planted at arbitrarily selected spacings and left to fend for themselves in soils where fertility for most crops has declined by virtue of years of continuous cultivation. Not infrequently, through lack of sufficient planting material, individual stools which failed to make growth could not even be replaced. Nevertheless, under these conditions grass has grown but after three or four years yields of cut fodder decline markedly and grazing efficiency as reflected in the number of cow-days, also regresses. When the grass is eventually replaced (possibly after a five year ley) by a subsistence crop (e.g., upland rice) disappointing results have frequently been obtained. There are as yet no suitable power implements to turn the sod under and no practical alternative other than a timed programme of stumping and burning the rooting system and the fibrous stems before cultivation, are yet available. Furthermore, the "thumb and forefinger" field test as an index of texture has more often than not revealed little indication that a soil's physical properties

had benefited from the vegetation it supported: visual evidence showed that no mineral-humic topsoil had formed analogous to that which develops, in time, under conditions of undisturbed forest regrowth.

59. Thus, grass when planted from stools and left to grow unattended until it is grazed or cropped for green material or hay will yield for a few years and thereafter become devitalising. It cannot be reasonably expected in these circumstances to either regenerate fertility or restore crumb structure for the functions of its rooting system are over-burdened in the processes of utilizing soil compounds (including water) to develop leafy herbage to feed livestock directly by grazing or indirectly, in paddocks, after cutting with crude implements. Such an intensive system of management does not yet harmonise with rest periods under which grass can provide residues (and their decomposition products benefit the soil), nor does it favour the work of grass roots in a role of soil reconstruction.

60. It would therefore appear desirable to pause and explore the use of grass primarily from the viewpoint of its possibilities in benefiting a soil and for the time being at least regarding the yield of palatable fodder it can supply as a subsidiary though important product. It is advocated that attention is directed in the first instance to the establishment of grass as a cultivated crop and implied that experiments should be laid out under varying conditions of soil, climate and topography in order to evolve specific treatments in establishing grasses in specific areas.

61. A beginning to this work has been made this year at three centres—Newton, where the soil is deep, easily eroded sandy loam developed from Pleistocene sands under a rainfall of 120 inches; Njala, where the soil is a deeply weathered gravel loam laterite developed from sedimentary shales under a rainfall of 110 inches and at Musaia where the soil is a reddish-brown loam Lateritic derived from the granitic basement complex under a rainfall of about 80 inches. The nutrient status of the soils at Newton and Njala are low in respect of N. P. and K. for most cultivated crops and field experiments set down this year were directed to adjusting soil deficiencies in order to establish good stands of grass. Different forms of phosphatic fertilizers (superphosphate, ammophosphate and silicophosphate) and different forms of nitrogen (calcium cyanamide and sulphate of ammonia) were used. Potash where applied, was in the form of the sulphate. Grasses for establishment included Panicium Maximum from South America and from Puerto Rico and also a dwarf species of Panicum Maximum (C.I.P8387).

62. From the evidence available at the end of 1949 the view can be expressed that the use of N. P. and K. in establishing good stands of grass in its first year has been demonstrated and that complete omission of these elements causes delayed and less vigorous growth. With regard to improving worn out Guinea Grass grassland: on the theorem that grasses can assimilate ammonia directly and without prior nutrification, the times of application of nitrogen in the form of sulphate of ammonia are being varied where dressings of potash and phosphate have been given. The practical significance in attempting to maintain a satisfactory potash and phosphate status while adjusting the application of nitrogen will find expression if it can be conclusively shown that this form of treatment points towards an extension of the duration of the present grazing season and provides an early bite in the following year. It has been shown this year that September applications of sulphate of ammonia do favour the late production of leafy herbage for grazing or cutting.

Use of Fertilizers

63. A suggestion has recently been advanced that the proportion of lowland (padi) rice raised in the world may be expected to increase in sympathy with a rising world population coupled with insufficient suitable soil and appropriate fertilizers to raise other cereal (upland) crops to feed the people.

However broadly this statement may be applied to the world in general is not known but in relation to Sierra Leone, where for many years efforts have been directed to stimulating significant advances in the utilization of river valleys and depressed land forms for the cultivation of " swamp " rice, it is most certainly perspicuous. The early chapters of this report were devoted to describing the forms of land reclamation (saline swamps, alluvial swamps hygrophilous grassland etc.) in progress for the production of rice: later chapter described methods now being assayed and the difficulties involved in endeavours to reconcile upland crop production and soil reconstruction and indicated that such methods are almost entirely based on the appropriate use of specific vegetation (tree covers, leguminous covers, grass covers) to circulate plant nutrients and to conserve soil moisture. In these circumstances, whereas the actual production capacity of a soil for a specific crop can be determined, its potential crop producing capacity must necessarily remain unknown. To meet this latter requirement therefore, many field experiments have been made with a view to measuring the maximum yields which can be produced by a specific crop under a given set of conditions when fertilizers are used. That much attention has been given to rice is perhaps not without justification and records of experiments involving the use of this crop are given in detail.

64. It is becoming more widely recognised both in field and laboratory practice that crops are not particularly efficient in utilizing fertilizers. This is especially so in the case of the phosphates where it is believed that up to three quarters of the phosphate contained in a fertilizer may never reach the crop for which its application is intended. Instead, it reverts to insoluble and useless forms in the soil mass. Placement within the expected root range of a crop may be anticipated to eliminate some of the difficulties and point the way to more effective methods of fertilizers application in the future. Exploratory Field work on these lines was continued this year, using sweet potatoes and French Guinea beans as test crops.

65. Descriptions of field experiments follow hereunder:

I. Rice

66. *Rosino.*—A field experiment was put down in the frontal area under the somewhat unsatisfactory conditions already related. Nitrogen was used in the form of calcium cyanamide and sulphate of ammonia: phosphate in the form of silicophosphate and superphosphate. The two nitrogenous fertilizers were applied at a rate equivalent to 1.6 cwt. per acre, silicophosphate was applied at the same rate and superphosphate at double that rate. Phosphates were used alone and in combination with the two forms of nitrogen.

67. The resulting yields of padi rice, though markedly low were nevertheless greatly superior to that of the control where only 158 lb. padi per acre were obtained. Silicophosphate, when used alone or in combination with one or the other forms of nitrogen gave from twofold to fivefold increases on this figure and superphosphate, alone and in combination with the nitrogenous fertilizers gave up to fourfold increases in yeild. The evidence available points to the advisability of pursuing further experiments in which phosphatic and nitrogenous fertilizers are included.

68. *Kamakwie.*—This place is situated at 12° 15′ West Longitude and 9° 30′ North Latitude. An exploratory field experiment was laid out on one of the ubiquitous seasonal fresh water swamps close to the town and the experimental area included part of the first bottom and valley margin in the depressed topography. The soil, derived from the granitic basement complex consists of pale grey quartz sand over pale grey kaolinitic clay with quartz sand. Rainfall recordings are not made here but the annual precipitation is believed to be less than 100 inches.

69. The fertilizers and their rates of application were the same as those recorded for the previous experiment. The two forms of nitrogen in this instance were also tested alone. A summary of the yields obtained is presented below in pounds padi per acre:—

	—	*Superphosphate*	*Silicophosphate*
Sulphate of ammonia	1,260	1,900	1,820
Calcium cyanamide	1,240	2,060	2,260
——	1,020	2,080	2,260

70. The data presented would appear to indicate that whereas the application of a nitrogenous fertilizer may be expected to contribute to the productivity of this soil when rice is grown, the substantial increases in yields which accrue when phosphatic fertilizers are given seem to point to the soil's phosphate status as being one of the principle factors controlling fertility in respect of this crop.

71. It is not unusual to observe that when rice is grown in an inland seasonal swamp depression, there exists a visible and frequently measurable productivity gradient. Along the margins of a permanent or an intermittent stream dissecting a swamp rice is invariably characterised by its deep tillering, sturdy growth and development and a somewhat late maturity. These qualities however, decline progressively in the direction of a stream's first bottom and its contiguous valley margin, but where the rice ripens several days earlier. That two additional untreated, ponded plots on the margin of and parallel to the direction of the course of the stream which dissects the Kamakwie swamp yielded an average of slightly more than 3,000 lb. padi per acre which required to be harvested several days later than treated plots is not therefore anomalous under the conditions of this experiment. It does suggest nevertheless that future work on fertilizer practice in inland swamp areas will require to recognise and take into account the variation in such factors as ground-water and soil-moisture conditions etc. which exist between soil and plant from a stream's margin to its valley margin.

72. *Makeni.*—This exploratory field experiment was layed out on a seasonal swamp which forms part of the Departmental Farm at Makeni. The annual rainfall at this station averages 115″–120″ annually, and the soil type is essentially the same as that at Kamakwie. Fertilizer treatments and their rates of application were also the same as in the previous experiment. A summary of the yields of padi rice is given below:

Lb. Padi per Acre

	—	*Superphosphate*	*Silicophosphate*
Sulphate of ammonia ..	957	2,673	2,574
Calcium cyanamide ..	1,881	3,366	1,947
———	734	1,254	1,617

It will be observed from the above data that under the conditions of this experiment calcium cyanamide has caused a marked increase in yield over the control and much in excess of that caused by sulphate of ammonia. Individually, silicophosphate has given a yield superior to that produced by superphosphate but the combination of superphosphate and calcium cyanamide here, appears to be the most effective fertilizer treatment.

73. *Njala.*—A reddish-brown gravel loam ' Lateritic ', derived from shales and sandstones. The soil was fallowed in 1948 after several years of continuous cropping. Upland rice was broadcast at a seed rate of 60 lb per acre.

Treatments: 9 Replications: 4 Plot size: 1/45 acre
Fertilizers: 10 tons Compost over total area.

P = Superphosphate	at	3.2	cwt.	per acre
P′ = Silicophosphate	„	1.6	„	„ „
N = Sulphate of amonia	„	1.6	„	„ „
N′ = Calcium cyanamide	„	1.6	„	„ „

A summary of the results is given below in cwt. padi per acre.

	—	P	P′	Mean	
		(+0.973)			
— ..	6.23	5.83	5.52	5.86	
N ..	7.03	7.63	6.53	7.06	(+0.562)
N′ ..	7.53	7.33	6.93	7.27	
Mean ..	6.93	6.93	6.33	6.73	
		(+0.562)			

N and N′ both give an increase over 0 but neither is significant.
N′—0=1.41. S.E. of difference= $\sqrt{2}\times 0.562=0.795$ t.=1.77.
P′ decreases the yield but again, the difference is not significant.

74. *Wellington.*—A sea-clay soil, nearly reclaimed from littoral beach deposits in the Colony peninsular (*see* para 33). The experiment here was observational and had the following lay out:

Treatments: 8 Replications: 2 Plot size: 1/64 acre.

Fertilizers:

N=Sulphate of amonia at 2 cwt. per acre
P=Superphosphate „ „ „ „
K=Sulphate of potash „ „ „ „

A summary of the mean results are shown hereunder:

Grain: cwt. padi per acre.

	—	P	K	PK	Mean
— ..	18.3	21.7	18.9	19.7	
N ..	18.3	19.7	24.0 (i)	18.3	19.6

(i) one reading only.

75. *Maswari.*—A seasonally hydromorphic—halomorphic deltaic soil near the mouth of the Ribbi river, part of which was poldered for rice cultivation several years ago. In this experiment, rice nurseries received fertilizer treatments at rates of application shown below; and at the time of transplanting, the seedling rice received the same treatments again in the polder:

Layout—Blocks: 4 Treatments: 8 Replications: 4
Plot size: 1/40 acre.

Fertilizers:

N=Sulphate of amonia at 2 cwt. per acre.
P=Superphosphate „ „ „ „
K=Sulphate of potash „ „ „ „

A summary of the results is given below:

Grain: cwt. padi per acre.

	—	P	K	PK	Mean
— ..	16.3	26.9	16.1	17.3	19.1
N ..	19.3	24.9	18.0	25.3	21.9
—	17.8	25.9	17.1	21.3	20.5

The mean effects and interactions are:

Mean	N	P	NP	K	NK	PK
20.5	2.7++	2.3	0.3	—2.7++	2.2+	—1.7

S.E. of response to N, NP, K, NK ± 0.76

S.E. of response to P, PK ± 1.08

Straw: cwt. per acre

	—	P	K	PK
—	62.9	86.0	75.8	88.6
N	87.3	123.6	85.1	110.5

Mean	N	P	NP	K	NK	PK
91.8	19.7++	14.3	2.9	—3.5	—4.2	—10.1

S.E. N NP K NK ±5.30

S.E. P PK ±7.50

The reason for the different standard errors is that P was confounded with columns in one square and PK in the other; thus they are found from half the total number of plots.

Grain: Straw ratio

	—	P	K	PK	Mean
—	0.26	0.31	0.21	0.20	0.24
N	0.22	0.20	0.21	0.22	0.21
Mean	0.24	0.26	0.21	0.21	0.22

I—RICE

76. *Rokupr.*—(i) Block 14—The experiment consisted of a randomised block containing: treatments 8, replications 2.

The fertilizers used were:—

P=Superphosphate at 2 cwt. per acre
P″=Ammophosphate ,, 1 ,, ,, ,,
N=Sulphate of ammonia at 2 cwt. per acre.
N′=Calcium cyanamide at 2 cwt. per acre.

The means of yields obtained are expressed in cwt. padi per acre.

	—	P	P″		Mean
N ..	14.8	14.8	14.8		13.8
N′ ..	12.4	11.4	11.1	(±2.74)	
— ..	—	15.0	15.8		

Mean of N NP	NP″	Mean of N′	N′P	N′P″	Difference—N N′—N
14.8			11.6		—3.2
	(±1.58)				(±2.24

No significant results were obtained from this experiment.

(ii) A second randomised block experiment consisted of:

Treatments: 9 Replications: 4 Plot size: 1/38.85 acre

The fertilizers used were:

P=Superphosphate at 3.2 cwt. per acre.
P′=Silicophosphate at 1.6 cwt. per acre.
N=Sulphate of ammonia at 1.6 per acre.
N′=Calcium cyanamide at 1.6 cwt. per acre.

Totals of treatments are shown in lb padi below:

	—	P	P′	Mean	
— ..	50	135	117	100.6	S.E.± 19.18
N ..	104	150	124	126.0	
N′ ..	129	128	147	134.6	
Mean	94.3	137.6	129.3	120.4	

By the t. test there is significance if the difference between any two totals is greater than $2.064 \times 9.592 \times 2.828 = 56$

Mean Yields: cwt. padi per acre.

	—	P	P′	Mean
—	4.31	11.63	10.09	8.69
N	8.96	13.00	10.70	10.88
N′	11.12	11.04	12.67	11.60
Mean	8.13	11.89	11.15	10.39

In this experiment superphosphate has given an increase over the mean yield of 3.7 cwt. per acre, silicophosphate of 3 cwt. per acre and calcium cyanamide of 2.9 cwt. per acre, all of which are significant. The increase of 2.1 cwt. per acre in respect of sulphate of ammonia is not significant.

II—Annual Crops other than Rice

77. *Njala.—A fertilizer experiment using sweet potatoes as the test crop:* Last year the result of a fertilizer trial clearly demonstrated the value of applying a basal dressing of compost together with N.P. and K. to produce large increases in yields of sweet potato vines and tubers. This year the following combinations of fertilizers, balanced to theoretically supply the same quantities of N.P. and K., together with the same basal dressing of compost, were tested with the object of obtaining a straightforward comparison of yield data:

Compost, ammophosphate, sulphate of ammonia and sulphate of potash against Compost superphosphate, sulphate of ammonia and sulphate of potash.

Where P as P_2O_5 = 22 lb. per acre, N = 8 lb. per acre, K as K_2O = 22 lb. per acre and Compost = 40 tons per acre. Spacings: 1 foot intervals between plants and 3 feet between rows.

From the first treatment a yield of 6,953 lb. of potato tubers per acre was harvested; from the second, 8,691 lb. The yields are higher than those obtained last year when the maximum yield produced 5,600 lb. per acre against a control which gave only 1,150 lb. These results seem to suggest superphosphate as being the more appropriate phosphatic fertilizer for this particular crop.

78. *Njala.—Field experiments using phosphatic fertilizers and French Guinea beans (Vigna sinensis) as the test crop.*

(1) Ammophosphate is a water-soluble phosphatic fertilizer containing 48 per cent P_2O_5 and 11 per cent Nitrogen. In its "shot" form it stores well in this country and the ease with which it can be handled is a particular advantage in "placement" practice.

In a "look-see" experiment, French Guinea beans were planted at 2 feet spacings between beans and 2 feet intervals between rows. On germination, a row consisted of 105 plants and two-thirds of a pound of ammophosphate, where applied, contributed 0.32 lb. P_2O_5 per row. The fertilizer was given to alternate rows when the plants were about six inches tall, being carefully placed around the base of the stems without actually coming in contact with them. The topsoil was then "hoed-up" around the plants to hold the ammophosphate in position. Untreated rows were not hoed.

The mean yield from 32 phosphate-treated rows gave 2 lb. 3 oz. of shelled beans: 26 untreated rows yielded an average of slightly less than 1 lb. of shelled beans.

French Guinea beans are a crop which come to maturity within 10 weeks of planting. In this experiment, planting took place on 11th May and the beans were harvested 63 days later, during which time. 25 inches of rain had fallen. In these circumstances, it is evident that ammophosphate has justified the expectation that in addition to its other merits it has indicated its value as a quick-acting fertilizer for this particular crop.

(2) Dressings of 5 tons compost with 1 cwt. of superphosphate and 5 tons compost with 2 cwt. of superphosphate were given to each half of a 1 acre block, the manure and fertilizer being carefully incorporated in the soil. French Guinea beans were planted at 2 feet spacings between beans and 2 feet intervals between rows on 11th May. On harvesting the plot receiving the first treatment yielded 237 lb. shelled beans: the plot receiving the second treatment yielded 270 lb. shelled beans. In September, after incorporating all plant residues in the soil the same crop was again planted using the same spacing and intervals between rows. The plot which had previously received the first treatment yielded 66 lb. and the adjacent plot gave 72 lb. of shelled beans—yields which, when calculated on a lb. per row basis, are not dissimilar to those obtained from untreated rows in the previous experiment. The second crop of beans were grown under almost exactly the same conditions of rainfall but nevertheless on the results obtained it does seem desirable to view with caution any expectancy of other than very modest residual values accruing when superphosphate is used on this particular crop under Njala soil conditions.

III—Oil-Palms

79. An examination of trade records in connection with the export of palm kernels from this country reveals the following data:—

Year	*Total exported in tons*
Average of 10 years (1938–1947)	50,188
1948	66,431

In terms of phosphoric acid, this country has been exporting the equivalent of 2,000–3,000 tons of superphosphate or £30,000 worth of this fertilizer annually during the past decade. It is not within the scope of this report to discuss the implications which these facts reveal but while exploitation of the wild trees continues and extensive programmes for the development of group plantations of imported types of oil palm are implemented, an understanding of the nutrient requirements of the plant does seem desirable.

80. A beginning to this work was made at Newton and Njala this year to observe the effects of different fertilizer treatments on the development of nursery seedlings. The nursery used at Njala is sited on exposed upper footslopes in undulating topography; where the soil is a shallow, easily erodable gravel loam laterite not retentive to moisture and which dries out rapidly from about the beginning of November onwards. Such conditions are not particularly attractive but nevertheless they are not dissimilar to large tracks of this country where the wild palm is found to-day as a secondary forest tree.

81. The fertilizers consisted of sulphate of ammonia (N), superphosphate (P) and sulphate of potash (K). They were applied in the following combinations: NP, NK, PK and NPK. The N:P:K ratio at Njala was 2:2:1 and rates of application were the equivalent of 3 cwt. per acre in respect of P and N and 1½ cwt. per acre in respect of K. At Newton the N:P:K ratio was 1:1:1 and rates of application were equivalent to 4 cwt. per acre.

82. The Deli oil-palm seedlings were brought to Njala from a large plantation at Masanki and transplanted in prepared nursery beds during the latter part of the month of August and early September. The fertilizers were applied on 27th September in order to reduce the beating effects associated with heavy August rainfalls and with the expectation that fertilizer leaching would also be minimised. The reduction in rainfall as the months advanced and the increase in the average number of hours' sunshine is shown below:—

	Rainfall	*Daily Average of Hours, Sunshine*
August	22.5	3.8
September	13.6	6.2
October	12.5	8.5
November	8.9	8.0
December	1.3	8.6

83. The fertilizers were carefully incorporated in the soil and a protective cover of grass spread over the soil surface and around the young seedlings. At the end of December it was not possible to detect any marked improvement in fertilized beds over beds receiving no treatment. Many irreplaceable seedlings failed to survive the transplantation, others suffered from the depredations of the soil's macroflora, but the lack of progress made by the majority could in large measure be ascribed to a deficit in soil moisture, especially during the latter part of November and throughout December. Young and shallow rooted oil palm seedlings cannot be expected to make vigorous growth in soil having an average earth temperature of 82°–83°F. (at 12"), in the absence of an adequate supply of soil moisture or make the most effective use of fertilizers, especially phosphates, the fate of which in most cultivated soils has already been outlined. A tentative assessment of the fertilizer treatments was made at the end of the year and in order of merit, gave as follows: NPK, PK, NK, NP.

84. At Newton, a parallel experiment had been put down during the first week in July using oil-palm seedlings from the same source, planted a month or so earlier in a freely drained, acid, sandy-loam soil. Several replacements required to be made during August and September but before the end of the year it was possible to detect differences in growth where fertilizers had been used. In this case, the order of merit was judged to be PK, NK' without any obvious differences between NPK and NP.

85. These two experiments are of an exploratory nature but they have this year illustrated very simply and successfully that the fertility of an oil-palm nursery not only depends upon an adequate supply of available plant nutrients but that other factors must be favourable. Where they are not favourable e.g. where soil moisture is inadequate or evaporation is excessive, such factors can be expected to greatly detain the growth and development of seedling palms.

SOIL SURVEYS

86. Reconnaissance soil surveys of areas in which field experiments were put down have been continued this year and many soils have been examined and described during the course of journeys made in the Protectorate. A collection of discrete "Laterite" gravel erosion remnants was begun and the Director of Geological Survey kindly described individual specimens.

87. A provisional classification is being prepared of some intrazonal halomorphic soils of littoral and deltaic origin and hydromorphic soils of swamps, seep areas and flats. Factors concerned in the classification include permanent conditions of marine inundation and seasonal, alternating conditions of marine and fresh water inundations in respect of halomorphic soils: permanent conditions of fresh water close to or above the soil surface throughout the year, and seasonal, alternating conditions of high or relatively high, fresh, ground-water tables in respect of hydromorphic soils.

88. The soils examined and described during journeys in the Protectorate are composed of pedalferic zonal soils—e.g. yellowish-brown and reddish-brown lateritic soils of hill crests and footslopes in association with intrazonal soils—e.g. hydromorphic soils and ground-water laterite soils of lower footslopes and seasonal and permanent swamp depressions (bolis). Where different ecological environments are encountered, endeavours are made to interpret the variations in relation to such factors as parent soil materials, their age and depth, climate and topography: other edaphic features, e.g. availability of ground moisture and differences in seasonal dryness etc. on the one hand and the biotic influences of man and fire on the other, are taken into account as contributory factors in determining the nature of the vegetation cover.

89. It is well known that for specific climatic environments there are dominant types of rock weathering processes and soil formation which, when fully developed lead to characteristic World Soil Groups. In the seasonally very wet, and permanently humid tropical climate of Sierra Leone parent soil materials are deeply weathered and profoundly leached; they support remnants of rain forest, secondary forest re-growth, or varying forms of savanna woodland. The depressed, mature topography of the well dissected highland plateaux and coastal plains reflect the effects of the geographical forces of denudation and erosion which have been active over relatively long periods of geological time. In the circumstances it is evidently desirable to exercise greater caution than to ascribe (as is frequently the case) soil " degradation " following forest destruction for cultivations solely and without qualification to the biotic activities of man and fire. Whereas there can be no doubt that these factors do contribute to accelerate the erodability of a soil which is cleared of its vegetation cover, they should not be over emphasised at the expence of the dominant climatic proesses which promoted its formation, especially should that soil occur in nature or old surroundings.

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